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OVERHEAD WIRES.

THE damage caused to overhead wires by the recent snow storm has produced in the daily papers the usual crop of correspondence on the subject. It is at first sight somewhat difficult to see why the wires should be the subject of attack whilst other dangers have been taken no notice of; possibly, however, the reason may be that the one is very directly noticeable. The writers, it may have been noticed, lay particular stress on the "danger" question. Now if the recent damage which has taken place has brought out one fact more plainly than another it is that the actual danger is absurdly exaggerated. The cases in which damage has been done to individuals by the falling wires are insignificant. Of course, that serious injury *might* have been done, as it *might* have been done from a hundred other causes, is undeniable, but in the face of actual facts the logic of this argument loses most of its force. We do not ourselves consider that overhead wires are by any means to be advocated as desirable appendages to housetops; they are decidedly unsightly and are sources of great *inconvenience* in cases of breakage, for the interruption of telephonic or telegraphic communication is very objectionable and the avoidance of it is a thing much to be desired. The failure of fire alarms, too, is a serious matter, as has recently proved to be the case. Here, it is true, we have a real source of danger, though not of the kind of which so much is written. Generally speaking, the whole matter is one of expense. In the case of fire alarm circuits this latter point should not, we think, be for a moment considered; the major portion of the mileage of such circuits is at present underground, and no time ought to be lost in making it wholly so; in any case, the expense which this would involve could not be extreme. As regards telephone wires, the question of expense would be a most serious one for the companies themselves. The working difficulties need not be considered, as telephonic communication can be carried on without difficulty through a far greater length of underground wire than any of the London renters at present require to work through; thoroughly good speaking has been carried on through an ordinary double underground line of a total length of 80 miles, the speech being so good that there was no doubt but that this distance could have been exceeded. To place all the telephone wires underground, however, would involve such an increase in the capital of the companies as would cause a heavy reduction in the dividends, for no increase in the present renter's rates could be ventured upon. The moral drawn by the correspondents to whom we have alluded is "No more overhead wires." When the Tay Bridge failed, was the moral "No more bridges?" Was it not rather "No more badly-constructed bridges." Let the overhead telegraph or telephone systems of wires be more strongly built and then the very slight accidents which we hear of would be reduced to insignificance and inconvenience reduced to a minimum.

A NEW SOUNDER WITH BI-RESISTANCE COILS.

A NEW and ingenious sounder has been introduced by Messrs. E. S. Greely & Co., successors to L. G. Tillotson & Co., of New York.

The sounder is designed principally to save the battery, which, with the usual form of sounder, is closed on low resistance. To effect this, states the New York *Electrical World*, the "economic" sounder contains two sets of resistance, and is so constructed that there is only the usual amount of resistance in its coils (about 3 ohms) when the circuit is open, so that it responds to the closing of the circuit with all the activity of the ordinary sounder. But as soon as the armature lever strikes the anvil, it throws 100 ohms resistance into the circuit, thus preventing the rapid absorption of the battery power incident to short circuit. As soon as the circuit is opened again, and the armature released, the sounder returns again automatically to the local basis with all the rapidity and smoothness of an unchanged resistance.

Computation from actual tests over an extended period of time shows that the average saving of battery power in large offices where the sounder is kept in most active use is very large, and in railroad offices, and especially in country commercial offices where the sounder is idle for a large part of the day, the saving is still greater. It robs nothing from the power of the instrument when the magnets are exerting their force to attract the sounder, but when that work is accomplished, it immediately throws into circuit its 100 ohms resistance as a guard against extravagant waste, and no matter how rapidly the work is carried on, it cannot be too quick for this ever-present and infallible guard that confines the outlay of strength to the limit of necessity, which has been demonstrated to be, in even the most active work, less than 25 per cent. of the whole power usually expended.

So far from its use exciting any prejudice in Morse practice, it has been remarked by operators after having had the instrument in use for some time, that the "economic" sounder gives forth a peculiarly soft, agreeable tone, with an entire absence of the racking thud of the ordinary sounder that shocks the oral tympanun, and renders a recurrence to its voice seem notably harsh and hard to a sensitive ear. There is a marked difference in tone between that of the up stroke and the down stroke, facilitating in a surprising manner the work of the ear in translating the sound, so that the rapidity of the same writing, by clearer partition of the signals, is made to seem much reduced.

Owing to the fact that under the principles of construction upon which the "economic" sounder is based, the cores of the magnets begin to demagnetise as soon as the armature strikes the anvil, and continue in the operation of demagnetisation up to a certain limit, the tendency to stick is reduced, it is safe to say, over 75 per cent.; and for the same reason the armature is more ready to answer to the tension spring upon the opening of the circuit, thus creating additional conditions favourable to clearer annunciation in rapid sending.

Electric Lighting in Mills.—Messrs. Gent & Co., of Leicester, have just completed an installation in the mill of Messrs. Rust & Co., the well-known spinners.

THE DAFT ELECTRIC MOTOR IN BALTIMORE.

MR. ROBERT L. HARRIS has lately given an account, at a meeting of the American Society of Civil Engineers, of the working at Baltimore of the Daft electric motor, now being tested on the Ninth Avenue line of the New York Elevated railroad.

The Baltimore and Hampden Railroad is a suburban line of about two miles in length; gauge, 5 feet 4½ inches. It was heretofore an old horse railroad, and is a feeder to a main line of the Baltimore horse railroads. It is now operated by the Daft motors. This road has iron rails, 25 pounds per yard, laid on cross-ties in a cheap manner, and runs along the side of suburban streets or roads. The country is undulating and the route is crooked. Its curves are from 40 feet to 90 feet radius, and the grades are from level to the rate of 330 feet per mile. The superintendent, Mr. T. C. Robbins, says there are only about 300 feet of continuous level on the route, and very little level on its entire distance. A 25 pound steel rail has been placed on insulators near the middle of the ties as a conductor, and was roughly guarded by joists and planks laid on each side of it. The reason for using 25 pound rails as conductors was simply that in case of failure they would be useful for repairs. It was unnecessarily large for a conductor. Electricity has been used upon the road in place of horses since September 1st, 1885. The sections of conducting rail, as also of the track rails, are electrically connected by wires. In some places these wires are not insulated, and the rails were connected by a mere loop of ⅛ inch copper wire. The connections at main dynamo are of ⅜ inch copper wire insulated. At the engine-house there is a boiler, two doors to the fire-box, 14 feet long, 5 feet diameter, with 60 3½-inch flues. The engine is 16 by 24 inch cylinder, which, with 30 pounds of steam at 110 revolutions per minute, is said to develop about 75 horse-power. This engine drives two nominal 50 horse-power Daft dynamos, which supply the electric current to the rail. The engineer said that when both motors, each with a loaded car attached, were ascending the steepest hills, the full capacity of his engine was used, but when neither were on a hill not 10 horse-power was used. This engine uses about 1½ tons of coal per day of 18 hours, with fires banked at night. Two motors are in use, each weighing about 4,500 pounds and rated at 10 horse-power. A new motor, weighing about 5,000 pounds and rated at 20 horse-power, had just arrived, and was connected with the current and moved about. The motion of the armatures was stated as about 1,200 revolutions per minute; they were geared to the driving axle of the motor by ordinary tooth geared wheels in the proportion of 12 to 1, and the speed of the motor arranged for 12 miles an hour. But one strength of current has thus far been used, of low intensity; there has been no occasion for other powers of current. No electric brake is being used.

We rode, said Mr. Harris, on a regular trip to the end of the road and back with a street car attached, such as is ordinarily used with two horses. The average load was about 18 passengers. We went around one curve of 40 feet radius on a grade of 275 feet per mile, and around a curve of 70 feet radius on a grade of 330 feet per mile. While we were ascending a grade of about 320 feet per mile, the other motor was said to be at the same time ascending a similar grade. We stopped near the middle of this grade and started from full stop without difficulty. The toothed gearing made some noise, but passing horses did not seem frightened. It is expected to avoid toothed gearing by friction gear. The motors are controlled by one man, and, with car attached, start from each terminus about once an hour, and pass each other by side track. Mr. Robbins told me that the Morse has run 1,006 miles with no repairs (except oiling). Its average duty is 75 miles per day. No especial skill is needed; he had at times run his motors with men taken right off the road. He is satisfied with this power, and hopes that his company will soon use it on the other 6 miles of suburban road which they own. His company owns also 14 miles of Baltimore city horse railroads. He considers that his present power would run on his road five motors, each carrying one car, and, were there but 150 foot grades on his road, his present power would run five motors with three cars each. As now run the two motors take the place of 30 horses and are as cheap, and were he running eight cars there would be a saving of one-half the cost of horses for the same duty. There has been no trouble in heavy rain and thunder storms; he thinks it works better in wet weather, and has even known the flange of the conducting rail to be in water for a short distance during a rain storm. He says two of the men that have run the motors were locomotive engineers, and their expression was, "It lays away over steam." In fact, he thinks steam would not, with such light engines, carry such loads up such grades as has been done by the motors. Mr. Robbins states that he had had no troubles other than mechanical, which are now remedied (the armatures and brushes were at first too light).

As a test for himself, Mr. Robbins once sent to the city for one of their heaviest cars...lbs.	5,100
And carried a load of 81 persons over the road (say 81 by 125 pounds) ... ...lbs.	10,125
The weight of the motor used was ... ...lbs.	4,500
Total ... ...lbs.	19,725
Thus, he says, that 19,725 pounds were carried over the road by one motor of ... ...lbs.	4,500
His engine and boiler cost, approximately...	$2,400
His two motors cost, approximately, $3,000 each	6,000
Total	$8,400

There is also the expense of conducting rails and wires, insulation, protection, &c.

His expense of running per day is 1½ tons of soft coal	$4.75
Engineer and fireman at power station ...	4.50
Or, excepting oil, waste, wear and tear, per day	$9.25

The above represents the cost of his power, and equals the work of 30 horses per day. The average receipts from the cars carried by the two motors are $18 per day, and he has taken (on a Sunday) total receipts of $86 in one day.

THE PRACTICAL GAUGING OF VOLTMETERS.

IT is known that measuring apparatus very rarely give concordant indications, says M. G. Rouy, in *L'Electricien*. This depends on initial errors in gauging, on the weakening of the magnets, and on molecular changes in the springs or on other causes. Hence follows the necessity for frequently regauging measuring apparatus.

We shall concern ourselves here merely with the gauging of voltmeters, that of ampèremeters having been already considered (*L'Electricien*, August 8th, 1885, No. 181, p. 529). The following is a method easily carried out with the same apparatus as those necessary for gauging ampèremeters.

Let us suppose that the apparatus in question is a voltmeter intended for measuring differences of potential not exceeding 20 volts, a convenient range sufficient for amateurs who wish to know the difference of potential at the extremities of their batteries or of the lamps of a private lighting installation. We arrange in circuit the standard, the resistance box and the galvanometer with its shunt. Let us take, *e.g.*, as standard, a Daniell element, where the zinc is immersed

in a solution of sulphate of zinc, half saturated. The electromotive force of such an element is 1·07 legal volt, and a Deprez-d'Arsonval galvanometer with a movable coil having, for instance, a resistance of 150 ohms. We regulate the resistance of the box and that of the shunt so as to give the galvanometer 100 divisions per volt. Let the resistance of the box be 1,000 ohms, and that of the shunt 10. With 20 volts we should therefore have 2,000 divisions, but if we render the total resistance of the circuit 10 times greater by putting 10,090 ohms in the box we shall have 200 divisions to 20 volts, or 10 divisions per volt; we can then appreciate exactly the tenth of a volt. We arrange then in the circuit a battery, the electromotive force of which is at least = 20 volts, and a rheostat for varying the difference of the potential at the extremities of the battery. We then measure simultaneously this difference of potential with the voltmeter to be calibrated and with the graduated galvanometer, and verify thus the exactitude of each point of the graduation.

Let us suppose, now, that we wish to recalibrate a voltmeter of 60 volts like those used for measuring the difference of potential at the extremities of arc lamps. We regulate the Deprez-d'Arsonval galvanometer so as to give two divisions per volt; therefore, as before, we had 100 divisions per volt, we render its sensibility 50 times smaller by multiplying the resistance of the box by 50. We then arrange in series the elements of the battery (Daniell, Leclanché or accumulators) in such a number that the electromotive force may be at least equal to 60 volts; and by means of two loose wires we take the difference of potential at the extremities of 1, 2 . . . . *n* elements successively with the voltmeter and the galvanometer.

If in place of a voltmeter of 60 volts we have one of 110 volts, such as those used in the Edison system of distributing electric energy, we operate in a similar manner, acting on the resistance and the shunt of the galvanometer, so as to have only one division per volt.

We may easily obtain the potentials necessary for graduating these apparatus by means of Planté's battery; 20 small accumulators mounted on the same stand may be connected in series or in quantity by the aid of a commutator. They are charged in quantity and then connected in series, and by means of loose wires a variable number of them are arranged in circuit with the voltmeter and the graduated galvanometer.

THE ELECTRICAL TRANSMISSION OF POWER TO A DISTANCE.

IN 1873 a well-known experiment, executed at the Vienna Exhibition by M. H. Fontaine, demonstrated the reversibility of the Gramme machine, writes M. Manceron in *Comptes Rendus*, and showed for the first time the principle of the transmission of power to a distance by means of electricity. This discovery has already received numerous applications: the interest with which the experiments made at Munich and Grenoble have been followed as well as those now in progress at Creil, show the importance which is attached to progress made in this direction.

The experiment of 1876 had a great success as a curiosity, but it was only in 1876 that the first practical utilisation of a principle now so fruitful was realised. This application was made in one of the establishments of the artillery at the workshop of precision at St. Thomas d'Aquin, placed under the orders of the President of the Committee of the Artillery.

This workshop which is specially arranged to establish standards of measurement and to make all the instruments of verification and control destined for the manifold uses of the artillery, possessed a very accurate automatic dividing machine, furnished by the firm Dumoulin Froment, and driven by means of a Froment electric motor and a battery. As the machine was in action only at irregular intervals, it was necessary whenever it was wanted for use, to fit up and take down the batteries, the maintenance of which involved great inconvenience. Captain Manceron, attached to this workshop, proposed to substitute for the battery an electric machine set in motion in the workshop itself, the current of which should actuate the Froment motor at a distance. M. Niaudet, of the firm of Breguet, with great kindness placed at the disposal of this office a small Gramme machine with a Jamin magnet. The attempt was quite successful and the batteries were finally laid aside.

Some time afterwards a circular dividing machine, worked by hand, was transformed and arranged like the former. A second motor thus becoming necessary, a dynamo-electric Gramme machine was purchased which was to serve also for other applications. The machine with the Jamin magnet was made the recipient instead of the generator.

The second of these two machines is mounted in an annexe connected with the workshop. The first, from which more precision is required, has been placed in a separate building in order to be as much as possible out of the reach of vibrations. The circuit is not more than 200 metres.

A rheostat by means of which the strength of the current can be modified, accompanies each motor and enables the speed to be regulated at will. The force to be transmitted is feeble; the work utilised is about one kilo; but the use of electricity has given in this case a convenient solution of a delicate problem.

This installation has not been modified since it was first put up. It was mentioned for the first time in an article by M. Niaudet, inserted in 1879 in the *Zeitsschrift für Angewandte Electricitäts Lehre*, published at Munich by Dr. Carl, Prof. of Physics at the Military Academy of that city. The author of the article, whilst asking for information on this subject, wrote on July 5th, 1879:

"These references have now a value which I will call historical. In a few years numberless and immense applications will be made: it is in my opinion of great importance to put it on record that the officers of the French artillery have anticipated the entire industrial world in this fruitful track."

Without raising here a question of priority, the Academy may permit us to declare once more in its presence that the Artillery is always attentive to effect progress when occasion permits.

MAGNETISM.

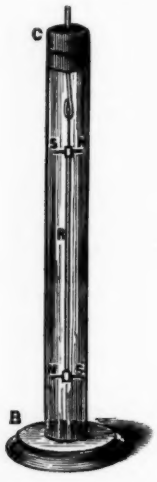
By WILLOUGHBY SMITH.

(*Continued from page* 34.)

It was thought that perhaps more accurate results would be obtained if the influence of the earth's polarised lines of force could be eliminated as regards the measuring magnet; therefore a glass tube 20 inches long and 2 inches internal diameter was fixed in a wooden base, B, diagram 6; C is a wooden cap fitted in the top of the tube. By means of a glass hook fixed in the centre of the cap was suspended, by a very fine silk fibre, the two small magnets marked, S N, N S, which were rigidly connected by a fine glass rod, R. The intensity of the magnetism in each was such that the couple was apparently unaffected by the earth's magnetism. A rod of charcoal iron, 10 inches by ·3 inches diameter, was annealed by being heated to redness in a forge fire, and there allowed to remain until the fire died out and the rod became comparatively cold; it was then supported horizontally on glass, and placed due north and south in such a position as to be in a direct line with the lowest magnet. Then by moving the astatic arrangement into different positions while the rod remained stationary, the directions assumed by the magnets indicated the direction of the magnetic

lines of force emanating from the iron rod. In experiments with this kind of measuring instrument great care must be taken not to place the magnets too far from the iron, because the low intensity of the magnetism induced in the iron by the earth's polarised

DIAGRAM 6.



lines of force is then insufficient to fully overcome the very slight torsion of the silk fibre, or the absence of absolute uniformity of magnetic tension in the small magnets. On the other hand, if the magnets be placed too close to the iron, it will be found that they induce magnetism into the iron, and, consequently, interfere with the results. It will, therefore, be understood why very careful adjustments are necessary before reliable data can be obtained. Figs. 1, 2 and 3, in diagram 7, show the results obtained with a rod, square plate, and a disc of iron. The arrows indicate the direction assumed by the magnet in each position in which it was placed relatively to the iron, which, in each case remained stationary. The results are very similar to those obtained by the single mirror reflecting magnet; and, as that arrangement was more easy of manipulation and accurate in measurement, it was again used for all similar experiments.

If permanent polarity, however slight, has been communicated to either iron or steel in any form by any known means, the intensity and direction of its polarised lines of force can be measured. A ring made from a steel rod ·375 inches diameter was hardened in oil and then mounted on a wooden disc, through the centre of which passed a small spindle, to allow of the ring being easily revolved vertically at right angles to the small suspended magnet, the distance between the two being 18 inches. No effect was observable on the magnet, although the ring was revolved several times. The outer surface of the ring was marked off into eight equal parts. One of these lines was marked S, and magnetism was then imparted to the ring as follows. The south pole of a powerful permanent steel bar magnet was placed on that part of the ring marked S, and the ring was then slowly revolved until its circumference had passed *once* under the south pole of the magnet, so that the point of first and last contact was at the line marked S. The bar magnet being removed, the ring was again very slowly revolved at the back of the suspended magnet, and under precisely the same conditions as before, and, when each line marked on the ring was directly opposite the centre of the magnet, the amount of the deflection of the magnet, as indicated by the reflection from the mirror, was noted. Diagram 8 shows the results obtained, H indicates the position of greatest effect, and L the position of no effect. It will be seen that the point of no effect is near to the line S, that being the place at which the magnetism commenced and ended; and that the point of maximum intensity is farther from S in the opposite direction.

DIAGRAM 7.

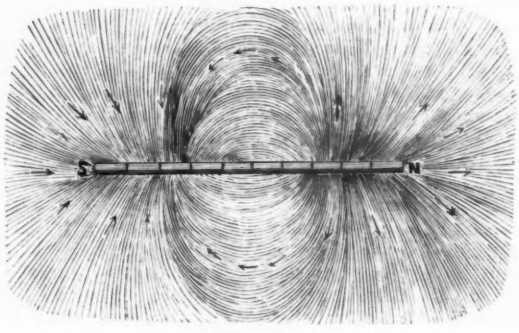


FIG. 1.

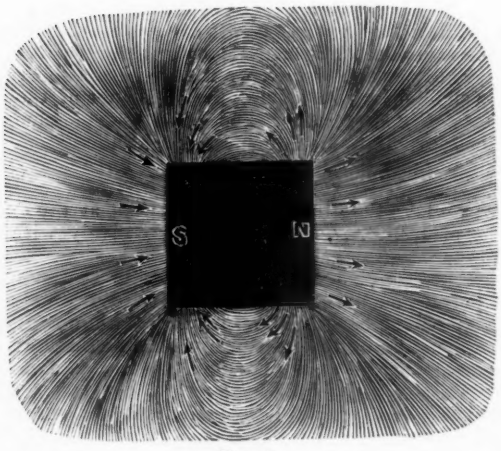


FIG. 2.

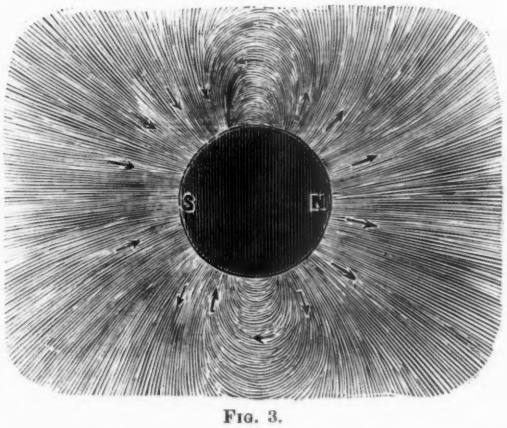
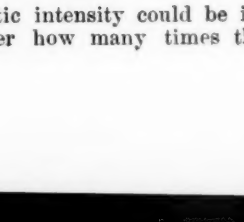


FIG. 3.

It was also observed in this experiment that after having passed the magnet once round the ring no

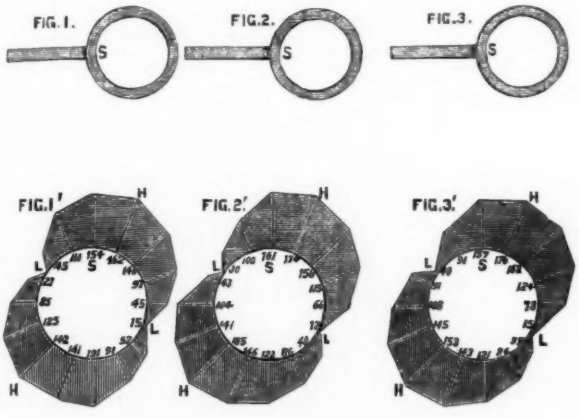
DIAGRAM 8.



greater magnetic intensity could be imparted to the ring no matter how many times the magnet was

applied, providing it was each time applied over the same part of the surface. But if it were passed over another portion of the surface, then the magnetic intensity of the ring was slightly increased. To further investigate what to me was a new phenomenon, a square edged ring, 8·5 inches internal, 9·5 inches external diameter, and ·5 inch thick, was cut from a plate of best "Lowmoor" iron. The object was to avoid a welded joint, which it was thought might, in some way, have influenced the results obtained in the last experiment; and also, by having four sides to the ring, the surfaces could be each magnetised with greater precision than possible with the rounded sur-

DIAGRAM 9.



face of the first ring. This ring was manipulated and tested in precisely the same way as the previous one. When magnetised around its edge, as shown in fig. 1, diagram **9**, the results were as given in fig. 1′ in the same diagram, the figures representing the deflections noted when that part of the ring was in a direct line with the centre of the small suspended magnet. Figs. 2 and 2′ show the results after the magnet had also been applied to the top side of the ring, and figs. **3** and **3**′ after the magnet had been passed over its under side. Looking at the total of all the deflections of each test it will be seen that the increase of intensity is very small for the additional application of the magnet on either of its sides. These experiments were continued with a steel bar in the place of the ring, and it was found that if the bar were magnetised by drawing the magnet from end to end, as in fig. 1, diagram 10, then the maximum

DIAGRAM 10.

result is obtained by the first rub, unless a fresh surface of the bar passes under the magnet; but if the magnet be passed from the middle of the bar to one end, and the magnet being then reversed, it be passed from the same point of the centre of the bar to the other end, as in figs. 2 and 3, then the induced magnetism in the bar is increased by repeated applications of the magnet. In one experiment the following values were obtained:

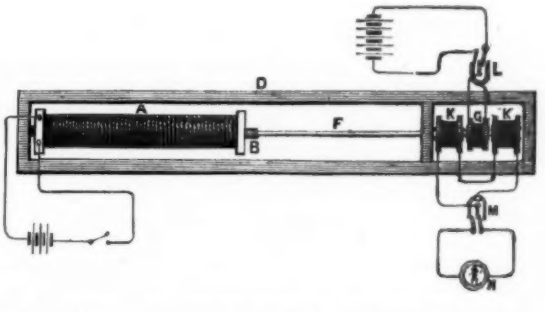
After one rub, deflection	...	...	137
„ five rubs, „	...	...	156
„ ten rubs, „	...	...	176
„ fifteen rubs, „	...	...	180

Although the magnetism induced into the bar is only increased by repeated application from 137 to 180, or thirty-one per cent. as measured by the energy of its polarised lines of force, yet its attractive power is nearly doubled, as the attraction between a magnet and its armature increases as the square of its "free magnetism." In drawing the magnet along the bar from end to end, as shown in fig. 1, it was observed that the ends of the bar were not of the same intensity, the end, B, where the magnet leaves the bar, being considerably stronger than the point, A, where the contact was first made.

It is just 100 years ago since it was first asserted that if an iron wire, not less than ten yards in length, were stretched in the open air, it would spontaneously give forth a sound when under the influence of a certain variation of the state of the atmosphere. On investigation, this was attributed to the effect of atmospheric electricity, and the correctness of that supposition was confirmed when it was demonstrated that the discharge from a Leyden jar through an iron wire produced the same phenomenon; but no further notice appears to have been taken of the subject until 1837, when attention was called to the fact that if a flat spiral through which a current of electricity is passing, be brought near the pole of a powerful magnet, a sound would be heard. In the following year it was made known that if a soft iron armature be revolved rapidly before the poles of a horse-shoe magnet, a sound is produced, and in 1843 it was noticed that plates or rods of iron, when placed in the interior of a helix, gave a very decided sound each time the helix was connected with, or disconnected from, a strong electrical battery; it being also, at the same time, asserted that a decided elongation of the iron rod occurred simultaneously with the sound. These phenomena were attributed to a change, produced by the magnetism, in the molecular constitution of the magnetised iron. The sound can be distinctly heard without external aid, but the supposed elongation of the rod requires very delicate appliances for measuring it, as under the most favourable conditions it is very minute. Prof. Joule, in one of his experiments, found that a bar of soft iron experienced "a decided elongation," which was about $\frac{1}{720000}$ of its total length, at the moment when the current by which it was magnetised was established, and a shortening at the moment when it was interrupted. These phenomena have frequently engaged the attention of experimenters, but no definite or satisfactory results have, as far as I am aware, been arrived at.

It has recently been experimentally demonstrated that a rod of iron only increases in length up to a certain point, and that if the strength of the exciting current passing through the helix be increased after the maximum length is reached contraction commences, and the bar apparently becomes shorter than its original length. In my research in this direction, great difficulty was, at first, experienced, from the want of a simple but, at the same time, efficient measuring apparatus; this was at last overcome by the construction and adoption of the apparatus as shown in diagram 11; this arrangement proved most valuable, not

DIAGRAM 11.



only for these experiments, but for measuring the expansion and contraction of metals under the effects of varying temperatures, and other similar experiments; in fact, as a gauge it can be made as accurate and sensitive as "Newton's scale of colours."

A, is a helix of cotton covered wire (·083″ diameter) wound in 10 layers of 198 turns each, the resistance of the entire length being 1·613 ohms. Inserted in the helix is the iron bar, B, 1·375 inches diameter and 27 inches in length; one end is rigidly fixed to the wooden frame, D, and the other end carries a glass rod, F, the further end of which passes freely through the hollow iron core of bobbin, H, and supports the centre bobbin of wire with hollow iron core, G. A fine screw adjustment permits this bobbin to have a movement of about half an inch along the glass rod, so that it can be placed in any desired position between the similar bobbins, H and K, which are rigidly fixed to the wooden frame, D. A rapidly alternating current can be sent through the wire on bobbin G by means of a reverser, L. The wire on bobbins H and K is so joined that the electromotive force induced therein from G exactly neutralises each when the bobbin, G, is placed midway between them, but under these conditions the slightest movement of G is sufficient to destroy this neutrality. In circuit with the wire on H and K is a reverser, M, which causes the induced current to pass in one direction through the mirror reflecting galvanometer, N. The glass rod was of sufficient length to allow H to be 31 inches from the iron rod, B, and at that distance no direct inductive effect from B apparently affected H. Having established the point of no current by shifting G until its neutral position was found, which was exactly midway between coils H and K, then, by means of the fine screw, G was moved $\frac{1}{3000}$ part of an inch from its central position towards K. This slight movement was sufficient to produce a deflection of 44·1 divisions on the galvanometer scale. Having obtained this "constant," the values given in Table II. were obtained. It will be seen on referring to the table that the apparent elongation of the rod has reached its maximum when a current of four ampères is flowing in the helix, and, as the current increases, an apparent contraction of the bar takes place until, with a current of 16 ampères, the rod appears to be of the same length as at the commencement of the experiment, and as the current is further increased, the length appears to diminish, and with 21·5 ampères it appears to be

TABLE II.

Coefficient of Instrument:—
44·1 divisions on Galvanometer scale = ·000333 of an inch.

Ampères flowing in magnetising helix.	Deflection on galvanometer.	Apparent increase in length.
1	1	·0000076 in.
2	4	·0000302 ,,
3	8·5	·0000642 ,,
4	9	·0000680 ,,
5	9	·0000680 ,,
6	8·5	·0000642 ,,
7	7·5	·0000567 ,,
8	7	·0000529 ,,
9	6	·0000453 ,,
10	5	·0000378 ,,
12	3·5	·0000264 ,,
14	1	·0000076 ,,
16	0	———
18	− 2	− ·0000151 ,,
20	− 3·5	− ·0000264 ,,
21·5	− 6	− ·0000453 ,,

·0000453 of an inch less than its original length. I have said *apparent* elongation and contraction of the rod, and I have intentionally done so, for it is my belief that neither elongation or contraction takes place. I have already stated that if a helix of insulated copper wire be placed horizontally, and one end of a rod of soft iron be presented at one end of the helix, it will be attracted into the helix on the first impulse of the current, and place itself so that its centre coincides with that of the helix. And also that a helix of insulated wire, enclosing an iron core, not only causes the iron to become and continue a magnet by induction so long as a current is flowing through the helix, but that the helix itself becomes a magnet, and possesses a sphere of magnetic lines of force quite independent of similar lines given out by the iron. This being so, it appears to me that, as soon as the current is passed into the helix, the lines of force from the rod endeavour to place themselves symmetrically with those given out by the helix, and thus, I think, is caused the slight movement of the whole rod, and not an elongation of it as supposed. When the rod becomes saturated, the intensity of its lines of force remain constant; but not so with those from the helix, as they continue to increase in intensity in proportion with the increase of the tension of the current passing through the circuit, and thus, I think, affect the lines of force of the rod, causing the latter to move in the opposite direction, which movement is mistaken for contraction. Just as I have shown the small magnet is moved by its lines of force adjusting themselves so as to be symmetrical with the lines proceeding from the iron rod or disc, so, I believe, is the iron rod moved by its lines of force adjusting themselves to those of the helix, and, I further believe, that the sound usually heard on making or breaking the current in an experiment of this kind is not due, as is supposed, to any effect in the iron itself, but is caused by the lines of force adjusting themselves to each other; for, as is well known, the more intense the current the louder the sound, as instanced in the sounds given off by what is termed the "discharge" from powerful electrical machines, or that produced by an electrical phenomenon of nature which produces the sound called thunder.

Although far from having exhausted the subject—in fact, it appears to me inexhaustible—I feel that sufficient, if not more than sufficient, has been written to accomplish the purpose with which this pamphlet was commenced. I will therefore conclude by remarking that, what I have written being intended for instruction and not display, I have avoided all those phrases and technicalities which are so apt to puzzle and mislead, and have endeavoured to express my meaning in plain and simple words.

ON THE EFFECTS OF THE "QUANTITY" RHEOSTATIC MACHINE.

FIG. 1 represents the latest arrangement which I (M. Gaston Planté, in *Comptes Rendus*) have adopted for the "quantity" rheostatic machine. Whilst in the "tension" rheostatic machine the mica-plate condensers are successively associated in quantity during the charge and combined in series during the discharge, in the present apparatus the condensers remain combined in quantity during both the charge and the discharge. Being separated by thin plates of ebonite they form a vertical battery arranged below a commutator, which can be thrown into a rapid movement of rotation, and which connects alternately these connectors either with the branches of a discharging rod, or with any other apparatus destined to be traversed by discharges.

I have already enumerated some of the special phenomena produced by the current *sui generis* which results from this continuous series of discharges of condensers re-charged incessantly with great rapidity by a source of voltaic electricity of high tension. But among the most remarkable effects I will mention what I have observed under the following conditions:—

If we cause the current derived from this apparatus to issue at the surface of a conductive liquid, such as salt water, by a wire introduced into a portion of capillary tube of 0·03 metre in length, and terminating at 0·002 or 0·003 metre from the extremity of the tube plunged into the liquid, so as thus to confine in a narrow space the quantity of matter submitted to the direct action of the current, there is produced a real

fountain formed of extremely fine drops, which rise to more than 1 metre in height (fig. 2).

The passage of the sparks into the liquid by the immersed tube is accompained by violent shocks and by a very intense noise; the mechanical force which comes into play in this narrow space is so considerable that it sometimes breaks the glass basin in which the experiment is conducted.

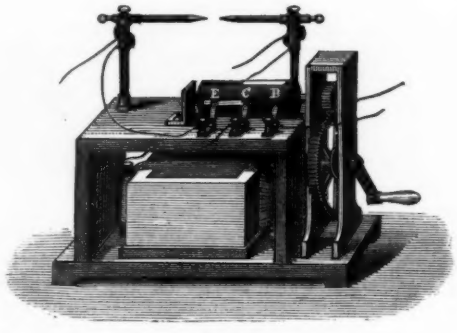


FIG. 1.

If the pole which enters into the tube is positive, the other electrode being entirely plunged into the liquid, the fountain is also produced, but it does not reach as great a height as when this pole is negative.

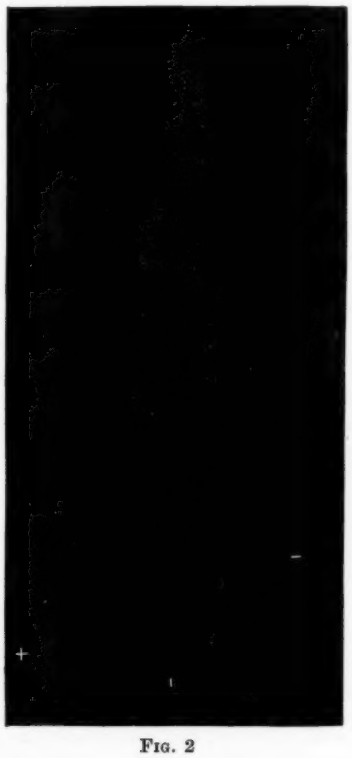


FIG. 2

When the electrode simply touches the surface of the liquid, without its extremity being enclosed in a glass tube, which partially insulates it, the liquid is only projected to the height of half a metre but it forms a sheaf of larger drops, and the vessel in which the experiment is performed is soon almost entirely emptied in consequence of the scattering of the liquid.

If the arrangement of the apparatus is reversed so that the extremity of the capillary tube near which the wire terminates is turned upwards instead of plunging into the liquid, and is kept merely moistened by the salt water, whilst the other electrode touches the upper portion of the tube, the spark produced, and continually renewed, takes the form of an irregular flame accompanied by a loud crackling, due at once to the mechanical pulverisation of the water, to the detonation of the gases derived from its decomposition and to the combustion of the sodium set at liberty.

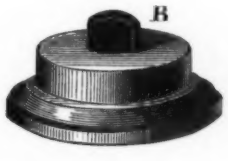
The experiment represented (fig. 2) imitates in a striking manner the effect of the extraordinary stroke of lightning at Ribnitz, which we have already mentioned (*Comptes Rendus*, C., p. 1388, and *Zeitschrift für Elektrotechnik*, May 14th, 1885), during which a jet of water rising from a soil drenched with rain followed the very track of the flash and entered a house through a hole which the lightning had pierced in the glass of a window.

These experiments explain, also, how, when a water-spout strongly charged with electricity so as to manifest luminous effects or globes of fire at its extremity reaches the surface of the sea, it produces all around it a large sheaf of pulverised water, and sometimes an ascent of water along the cloudy mass, or even in the interior of the vaporous channel of the spout.

SOME SWITCHES FOR ELECTRIC LIGHT INSTALLATIONS.

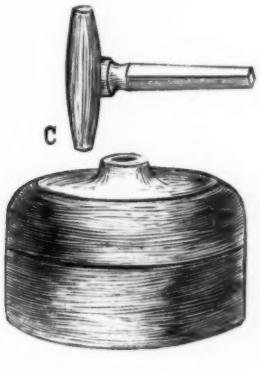
MESSRS. Woodhouse and Rawson have just brought out a set of switches of different types suitable to the varying circumstances of electric light installations. These we illustrate and describe under:

B is a small switch of neat appearance, in which a tongue of metal, fixed to a centre pin and handle, makes good rubbing contact between two metal plates, the connection being continued through a safety fuse



if required. A sharp, quick break is given by a spring, which also prevents inefficient contact being made. This switch is made in two qualities and two sizes to carry respectively 3 and 10 ampères, and is turned out in various kinds of wood and different pattern covers.

C. This switch is somewhat similar to the B type, but connection between the two double contact plates at opposite diameters of the switch is made by cross

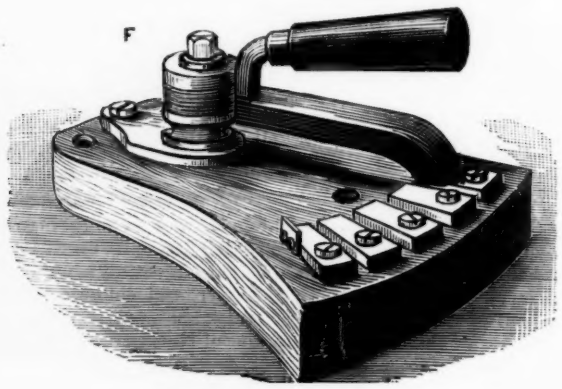


arm fitted with a square hole socket to receive a removable "railway key" handle, which can be made permanent if required. It is constructed in two sizes to carry respectively 30 and 60 ampères, and the base of the cover may be made in any fancy wood.

F. This switch has a movable arm, consisting of a number of thin brass plates, rubbing upon a set of

contact plates, and so making connection between the main terminals of the switch, which is attached to the centre fitting and any one of the contact plates. The

F



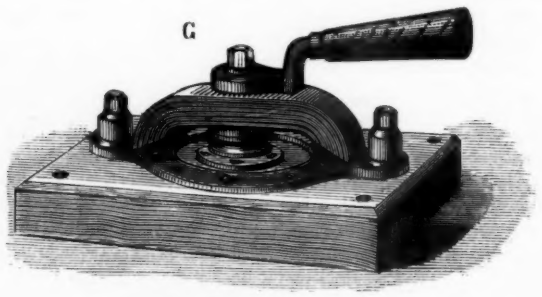
brass plates forming the movable contact arm are joined together only at the centre fitting, so that they form independent springs pressing edgewise on the contact plates and thus ensuring an excellent contact. The sizes made will carry 30, 60 and 100 ampères respectively. The switch is particularly useful where it is necessary to pass from one source through any one of a number of circuits, or through different parts or continuations of the same circuit; it is therefore very suitable for switching in or out resistances when these are required to be variable in the working of dynamos, &c., or cells of a secondary battery when a cheap switch is required.

G. This is an exceedingly strong and well-made switch and particularly suitable for heavy currents. It has a brass plate contact arm as in F switch, with the exception that the arm bridges two contact plates at opposite diameters of the switch.

The switch may be 1, 2, or 3, and the sizes made will carry respectively 60, 100, 200 and 500 ampères.

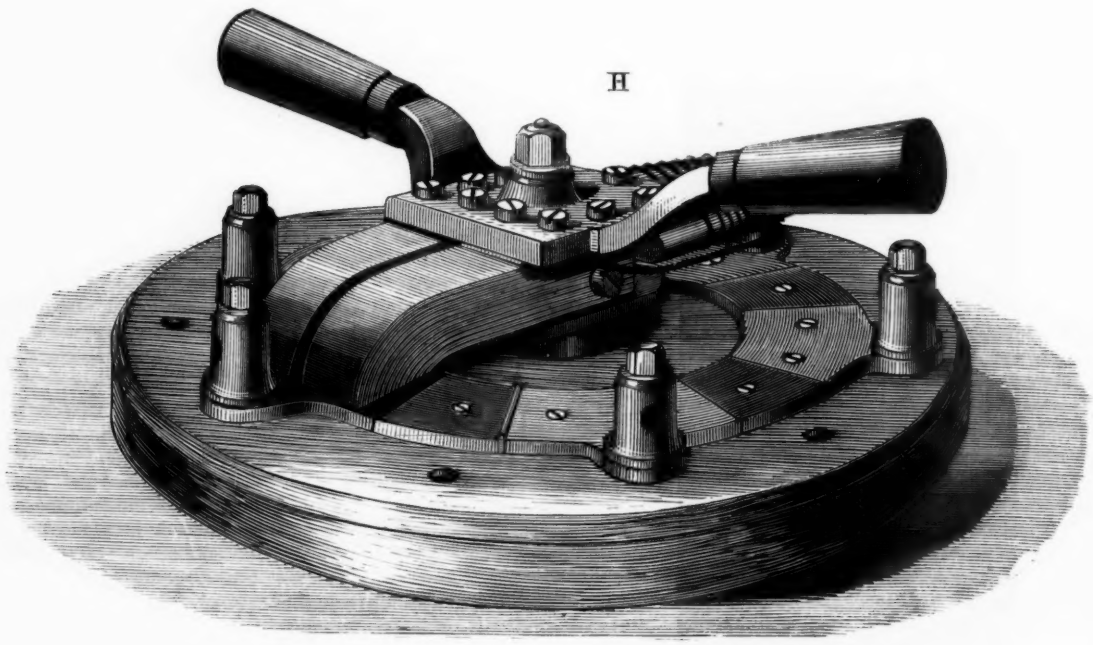
H. The switch ordinarily used for regulating the number of accumulators in a circuit consists simply of a set of contact blocks over which a contact arm moves as in switch F; but in using this switch the cells between any two contiguous contact blocks are short circuited every time the arm passes from one to the other. The H switch is designed to prevent this short circuiting, which very much injures the accumulator plates, and to prevent "sparking" which it does when properly adapted to the circuit on which it is used.

G



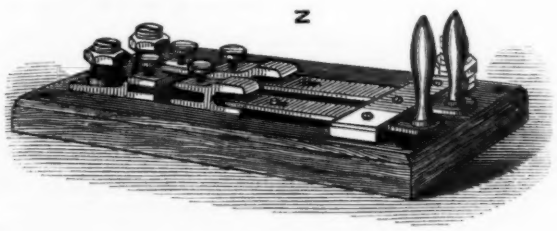
It has two contact arms or brushes, similar in construction to those of the F switch, rubbing over a number of contact plates connected to the cells; these arms are electrically connected to each other by a resistance coil, and are so arranged that one of them completely leaves one contact plate before touching the rest. When it does touch, the cell or cells between the two plates only are short circuited through the resistance until the switching motion is completed and the contact plate directly connected to the circuit. This is the only switch which gives these results without interrupting the main circuit; it is, of course, applicable in the case of primary as well as secondary batteries, and its use will very largely increase the "life" of accumulators and battery plates besides preventing the enormous waste of energy continually going on in the short-circuiting process.

H



Z. In nearly all installations it is necessary to subdivide the main current from the generating apparatus into several main sections, and this switch is specially designed with a view to this requirement. It consists of a guide plate connected to the main terminal of the switch through which slides an accurately-fitting metal bar, having at one end a convenient handle and

at the other a V-shaped spring contact which enters, and makes connection with, a brass jaw, this jaw having a fitting for a safety fuse through which the connection is continued to the branch line terminal. The number of slide bars with their jaws may be as large as is desired, all the bars being parallel to each



other and passing through the one guide plate, which is extended to the necessary length. By this arrangement any number of branch lines may be independently controlled and each has a separate safety fuse, while the construction of the switch allows the regulation of a number of circuits in a very small space.

SOME ELECTRICAL WORK IN 1885.

THE work carried out by the Anglo-American Brush Corporation during the past year comprises much that is of great importance as bearing upon the application of electricity in various industries in the future. The thorough manner in which its installations have been designed and carried out has also contributed in no small degree to the revival of confidence in electric lighting which is now beginning to be felt by the public.

Much has been done during the past twelve months towards perfecting the various kinds of electrical apparatus manufactured by the Corporation, who hold the unique position of being the only firm in this country supplying both high and low tension dynamos and arc and incandescent lamps manufactured by themselves. The exceptional facilities thus offered to improvement in combinations of plant used in every branch of electrical engineering have been thoroughly utilised by the company.

The high reputation which the Victoria dynamo has earned ever since its practical introduction has, during the past year, been fully maintained. This machine has been extensively employed by the Home and Foreign Governments for both naval and military purposes, and it is now a well recognised article of commerce. The various other accessories to electric lighting such as projectors, signalling and torpedo search apparatus have obtained wide celebrity.

The introduction of slow speeds for both engines and dynamos, for which the facilities offered in this direction by the construction and form of the Victoria dynamo has been in a great measure responsible, has resulted in reliability of working on board ship—which is being recognised throughout the mercantile marine—and has imparted an additional impetus to the electric lighting of passenger steamers.

Considerable attention has also been paid by the above company to motor work, and motors of large powers have been supplied both at home and abroad to work in conjunction with Brush machines of high tension to transmit power over long distances.

The Brush dynamo and arc lamp, in which important modifications have been made, still continue to hold their own. It is hoped that ere long a practical and extended application of their use may be seen in the metropolis on a scale somewhat like that adopted across the Atlantic.

Foreign contracts have constituted no inconsiderable portion of the Brush Company's operations during the past year; but among firms to whom, or localities where plant has been supplied or installations successfully carried out in this country may be mentioned the following:—The Central Station at Glasgow and the Grangemouth Station and Docks for the Caledonian Railway Company; the Waverley Station at Edinburgh; South Kensington Museum throughout with the new Brush-Sellon lamps; Holloway Sanatorium at Virginia Water; the Woking Convalescent Home; Messrs. Ritchie & Co.'s Mills, Stroud; the Duke of Bedford's yacht, *Northumbria;* the yacht *Christine;* the Newbattle Colliery and others. Many similar contracts are in hand for the coming year, amongst others the lighting of a portion of the Colonial and Indian Exhibition.

The past year has not been an uneventful one for the Corporation. Besides the consummation of important policies, initiated with the view of extending the scope of the company's business and influence, it is hoped, from the extensive and successful work carried out, that during the past year the company has in a commercial sense turned the corner.

The past year has also witnessed many important changes in the composition of the board of directors. In the early spring the company lost, by the death of Mr. Ladd, the services of one of its original directors and the co-operation of one of the earliest workers in practical electric lighting. As a result of the amalgamation with the Great Western Electric Light Company, the Corporation secured the services of Mr. Braithwaite as a director, and later in the year Lord Sudeley and Major-General Webber, C.B., accepted seats at the board, the latter doing so in the capacity of managing director.

Messrs. Cox-Walker & Co., of Darlington, inform us that their work during the past year consisted largely of the manufacture, supply and erection of their electric watchman's tell-tale; their systems of fire alarms, telephonic apparatus, in connection chiefly with "acoustic" and "mechanical" telephones; Vyle's patent "easily-tested" lightning conductors; household bells and electric sundries. With respect to the tell-tales, they continue to give satisfaction, and the demand for them arises almost entirely from the private recommendation of those who have used them. Notable among other large establishments the firm have fitted the immense premises of Messrs. J. and J. Colman, at Norwich. The recording apparatus was placed in the central fire station, under the charge of the active and intelligent superintendent of the Fire Brigade connected with the works, Mr. G. Durndell, and night and day the apparatus is at work recording the perambulations of the policemen whose duty it is to constantly patrol the extensive premises. By means of wires, contact boxes and keys, the movements of the police are recorded every quarter of an hour from about 28 different stations. The system admits of any number of stations being placed on one line circuit or of a separate circuit for each station, and both methods may be and are worked at the same time or on the same recording barrel, which is also self-starting at any fixed time. The firm's fire alarms, automatic and otherwise, have been adopted in several large institutions and give every satisfaction. With regard to mechanical telephones, the firm claims to have a large experience, and expresses surprise at the results obtained from one of the "Byng" acoustic instruments in combination with the neat and ingenious little pulley line guides or insulators sent out with them. The firm anticipates an increasing demand for these instruments as their utility and practicability become better known and more appreciated; they are put forward as filling the gap between the electric telephone and the speaking tube. Messrs. Cox-Walker & Co. exhibited a large variety of their specialities at the Inventions Exhibition, and were fortunate in obtaining the only silver medal granted for any similar exhibit. At the end of October Mr. Harrison retired from the business, which is now being carried on by Mr. Cox-Walker and his sons, and the present year has opened with gratifying prospects for improved business in the centre of the iron industry.

C

SOME CONSIDERATIONS REGARDING INDUCTION.

By DAVID BROOKS.

ALTHOUGH Henry made known the existence of induction before the magnetic telegraph was brought into use, it was generally considered by practical men to be a myth, so far as concerned the operation of the telegraph. Varley and Stearns found it an obstacle to the successful working of duplex apparatus, and counteracted its effects by means of electro-magnetic coils and condensers. Edison was afterwards compelled to grapple with it in perfecting some of his telegraphic inventions. In the year 1868 the Prussian and French governments put up a couple of international wires between Berlin and Paris to be worked by the Hughes apparatus, and it was found that when the currents were intermitted upon one of the conductors a disturbance was produced upon the other. All of the leading electricians in France held a consultation for the consideration of the phenomena, and it appears by the records that they were about equally divided as to whether it was the effect of induction, or of actual lateral conduction. Extracts from the French journals found their way into American prints, a case in point being the *Journal of the Telegraph*, edited at that time by Mr. James D. Reid. M. Abel Guyot, secretary of the Commission d'perfectionment, communicated with me in reference to the phenomena, and as the disturbances took place in clear weather they were finally decided to be the results of induction. The discussion was participated in by Professor Hughes, Guyot, Blavier, Gavarret, du Moncel and others. While this interesting controversy was progressing similar demonstrations were observed upon the two wires put up along the Union Pacific and Central Pacific railways, between Omaha and San Francisco, and when the atmosphere was very clear and cold, producing a high state of insulation, it was found impossible to work more than one wire. These disturbances occurred only during clear cold weather. For months repairmen might have been seen on the rear of every train hunting for crosses which they never found in the form of actual contacts. The trouble, recurred, however, with the appearance of the first favourable weather. Mr. F. L. Vandenburgh and General Stager communicated with the writer in reference to the matter, and being familiar with like results under similar circumstances between Berlin and Paris, I came to the conclusion that the troubles were caused by induction. The entire subject, so far as the Western Union Telegraph Company was concerned, was referred to headquarters at New York, where it was decided that the whole difficulty arose from defective ground connections, the iron railway tracks being used for that purpose. In accordance with this theory some very large copper plates were shipped to Omaha and Salt Lake City to be used for earth connections in place of the railway track. Of course, the substitution of the ground plates failed to remedy the difficulty.

Induction can only be produced, or at least developed to its greatest extent, by very high insulation, whether upon parallel conductors, or in what are known as induction coils.

Noad states that "M. Ruhmkorff brought the induction coil to far greater perfection than it had hitherto attained by paying the greatest attention to the insulation of the secondary wire."

Some years since the writer secured a patent for saturating the bobbin of an ordinary electro-medical machine with insulating material, thereby increasing the effect produced upon the secondary wire to such an extent that it was as much as an ordinary person could endure without drawing out the plunger. The bobbin was immersed for 24 hours in melted paraffine at a temperature of 300° F., which expelled all the air and moisture from the cotton covering of the wire. I exhibited this improvement experimentally as applied to machines from different makers, but as their coils produced all the effect desired, by withdrawing the plunger, they could see no advantage in the increased effect produced, and consequently the patent has lain dormant. A coil so treated, however, is capable of being made in a much more compact form and with less length of wire. When currents are rapidly intermitted upon a telegraph conductor, a neighbouring parallel wire becomes charged in the same manner as the secondary wire in the induction coil. During the Centennial Exhibition, I laid a short cable from the outside of the grounds to the Department of Public Comfort. One of the conductors in this cable was used for the Edison automatic system, in connection with a wire to New York, and as many as 1,000 words per minute were transmitted through it. The very rapid intermissions of the current charged the other conductors of the cable to such an extent that they gave out a violent shock upon being touched, and these effects were produced at either end of the open wire, but had the two ends of the wire been brought together the discharge would have been double the intensity. In the central portion of the secondary wire there is a point where the tension is at zero. Mr. Preece shows this by the following diagram: *

One would suppose that if the insulation at points, *c*, *d*, was lowered the inductive effect would be increased, but it is not for the reason that the induced current goes to the insulator itself in proportion to its becoming a conductor, or losing its insulation, and consequently is not shown upon the parallel wire. The same effect is produced at the ends, A and B; therefore, inductive disturbances to be developed in a high degree require high insulation. It is influenced largely by other considerations and circumstances. There should be no other conductors in the neighbourhood, as may be demonstrated by the following experiment:

Let it be supposed that in the following diagram (fig. 2), an astatic galvanometer be attached to conductor No. 2 in a 50-wire cable 500 feet long. The galvanometer with its conductor being simply attached to earth, we charge number 1 with a battery of 100 cells.

In an actual experiment as we charged number 1 the galvanometer on number 2 produced a deflection of 130 divisions. It makes no difference upon which end of the conductor we place the galvanometer, the effect is the same, and the current going from earth into the conductor number 2 is the same; that is, of opposite polarity to the battery current. We have then a simple Leyden jar arrangement of positive and negative electricities, and produce what is familiarly known as the static charge. The experiment being repeated with number 3 conductor, also to earth, the change produces a deflection on number 2 of but 90 divisions on the scale. We then connect another to earth, and the charge produces a deflection of out 70 divisions on number 2. As we connect the remaining wires successively to earth, the effect upon number 2 is gradually reduced until as the last of the wires is attached the galvanometer needle is moved but 4 divisions.

The foregoing experiment shows how the inductive effects are lessened as neighbouring conductors are multiplied, and shows why it was that with additional wires attached to the poles on the route between Omaha and San Francisco the annoying disturbances either disappeared altogether, or ceased to be of sufficient effect to prevent their being used to their full capacity.

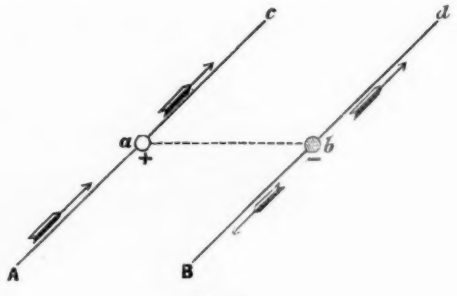


FIG. 1.

Up to this point merely the general principles of induction have been touched upon. Since the advent of the telephone, induction has been an important factor in electrical work, and all of the laws laid down as regards electrostatics seem to be set at defiance. The inductive effect is also found to be much more pronounced upon overhead telephone lines in clear cold weather than when rain prevails. If we take 100 telephone wires strung upon a line of poles, the wires arranged upon 10 cross-arms, each carrying 10 wires, one foot apart in each direction, we have 100 conductors occupying a sectional space of 100 square feet. If these wires extend one mile and are used exclusively for telephone purposes, we observe very marked inductive effects. By using insulated copper wire we may bring these 100 conductors within a space of one square inch. The law of inductive effect between wires is laid down by the authors of the present day as being inversely in proportion to the distance by which they are separated by insulation. Now, in the case of the telephone cable, the conductors are 14,400 times nearer each other than they are when they are in the shape of iron wires

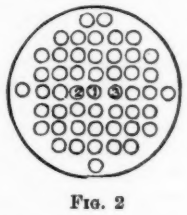


FIG. 2

strung on poles, and the inductive effects should be 14,400 times greater, but we all know that they are not. In the instance of the pole-line we use air as an insulator, which has the least inductive capacity of all substances, Fleeming Jenkin giving guttapercha over four times, and paraffine twice that of air. It would seem that the inductive disturbance in telephone practice is more of a question of acoustics than of ordinary electrical laws. I know from experiment that cotton or any of the textile materials saturated with paraffine has a much less electrostatic capacity than paraffine itself, and that cotton-covered wire when saturated with oil has much less electrostatic capacity than when saturated with solid paraffine. I can give no reliable data excepting that the more compact the cotton covering and the less oil or paraffine

* Journal of the Society of Telegraph Engineers, vol. iv., No. x., p. 68.

absorbed by it the less the electrostatic capacity. In experimenting with these materials I am frequently reminded of a patent issued to S. F. Van Choate, November 9th, 1869 (No. 96,641), in which he proposed to obviate the effects of retardation by clothing the wire with a dry textile covering before the insulator is applied.

The following is an extract from his specification and claim:

"Having selected a conductor of suitable size and metal, I proceed to cover it, first with a fibrous wrapping of clean silk, cotton or other equivalent, by winding or plaiting the same upon its surface in such a manner as to form a continuous interposed protection against contact of the wire with the gutta-percha or other preservative, protecting, or insulating material, after which I apply over the fibre a layer or coating of gutta-percha or other suitable substance or material, and otherwise protect said fibre and its enclosed conductor as may seem proper.

"The objects intended by interposing a coating of clean fibre between the conducting wire and the insulating or protecting material may be briefly stated.

"The electrical current which is found to be more or less retarded in case the conductor is covered directly with gutta-percha, asphaltum, or other gummy, bituminous or greasy substance, is, by the interposition of the clean fibrous cushion, saved from such retardation.

"I claim:—

"1. A conducting cable for telegraphic purposes in which a layer of clean, dry, fibrous material is interposed between the conducting wire and the insulating coating in the manner and for the purposes set forth."

Sound is very much deadened by the interposition of liquids. Had the late explosion at Hell Gate been above water, heaven only knows who would not have heard it; as it was, however, people standing but a short distance away heard a comparatively slight rumbling sound made more appreciable by the accompanying vibration of the earth.

One of the most interesting papers ever written upon induction so far as it affects telegraph wires, is that of Richard S. Culley, which was read before the Society of Telegraph Engineers, February 24th, 1875. The paper is not only instructive in itself, but the discussion which followed was exceedingly interesting, and was participated in by Messrs. Preece, Latimer Clark, and Adams. Mr. Culley showed by chemically prepared paper that inductive disturbances between wire and wire were far greater on overhead than on underground lines, and gives the substance of his experience in the following words:—

"As has already been stated, no inductive action could be traced between wire and wire in the underground pipes between the central station and Paddington, although they are four miles and 457 yards long."

. . . . . .

"Nor is there any record that induction between wire and wire was noticed on the buried wires formerly existing between London and Liverpool."

Mr. Latimer Clark stated "the first and obvious consideration is that we should place the wires (referring to overhead lines) as far apart as possible, and mix them about one among another so that no two wires run parallel for any great distance."

"Between London and Liverpool, a distance of some 210 miles, eight underground wires were laid in 1853. When they were first laid down they were in excellent order. We made a great many experiments on the effects of induction between wire and wire, and with the instruments we then had in use we were quite unable to perceive any induction from one to another. Even when we charged four of the wires suddenly with a strong battery power and put our receiving instruments on the remaining four we could not get any sensible discharge."

All of the recognised insulating materials are affected by temperature. The insulating property of gutta-percha is a hundred times higher at + 100° F. than at the freezing point. India rubber, paraffine, rosin, glass, and every solid substance of an insulating nature is affected by changes of temperature in the same way, but not in so marked a degree. Textile covering, however, like cotton, flax, hemp, jute and manilla show entirely different results. These materials in a natural state may be classed as conductors, but a cable or group of wires insulated with cotton at a temperature of + 300° F., when all moisture is expelled by heat, shows an enormously high insulation, and tests higher in that condition than when immersed in oil at a temperature of + 75° F., and although oil may be said to be affected to half the extent of gutta-percha by changes of temperature, a cable insulated with oil and cotton combined is very slightly affected by such causes, and the more compact the textile covering the less oil absorbed, hence the less affected by change of temperature.

The change of temperature in this climate can be said to range from 100° F. to zero. Under ground the conditions are different; the temperature of water from the hydrant varies between 80° at midsummer and 34° in winter in Philadelphia. As before remarked, inductive disturbance is much more apparent in clear and frosty weather than during rain or under the influence of heat of summer.

Moderately low insulation is the best condition for automatic telegraphing or telephonic operations. But to fix a proper medium to avoid induction is difficult.

Mr. Preece has stated to me that a megohm per mile is better than a higher degree of insulation as regards automatic or high speed telegraphy, and the same law applies to telephone service.

Retardation, which is so often harped upon, is the result of too high insulation. If the conductor has a moderate leak from beginning to end, this impediment does not show itself. Although it is desirable to have the insulation as high as possible when gutta-percha is used, because the higher the insulation the longer the life of the material when used under ground, the insulation can be reduced to a suitable standard for rapid work by putting in artificial leaks in the form of high resistance coils connected to earth at the way stations along the line. Such artificial leaks are placed upon underground wires in Europe to overcome this difficulty where the insulation is too high.

WESTERN UNION METHODS.

UNDER this title the *Financial News* of Tuesday last contained a dispatch from New York, dated December 28th, which said:—

"There has been considerable inquiry of late regarding the exact condition of the American Telegraph and Cable Company's affairs and its relations to the Western Union Company. The cable company owns two cables, which were laid in 1881, at a cost of about $7,000,000 and the company has a capital stock of $14,000,000, upon which the Western Union Company guarantees a dividend of 5 per cent. for 50 years. The company is a member of the cable pool, receiving 22½ per cent. of the pool receipts, against 48¼ per cent. paid to the Anglo-American, 16⅔ per cent. paid to the Direct Cable Company, and 12½ per cent. to the French Cable Company. The cable company makes no report direct to its stockholders, what little it cares to divulge being made through the Western Union. The little that can be learned must be learned inferentially and by comparison with the known business of other cable companies in the pool. The recent action of the Stock Exchange in striking the American Cable Company's stock from the list, owing to a dispute about the technicalities of certification, has stimulated speculation as to the actual value of the stock aside from the Western Union's guarantee.

"The outcome of these inquiries has not been particularly flattering, and some uneasiness has been expressed as to the solidity of the contract which the cable company holds from the Western Union. 'That contract,' said a stockholder of the cable company—a man as well versed in telegraphic affairs as any in the city—'is as binding as any contract ever made, and the report that it is so drawn that the Western Union can find a loophole of escape from it is, in my opinion, a report which has no foundation in fact. If ever a company was tightly bound to pay its guarantees it seems to me the Western Union is so bound, and the stockholders will secure their dividends even though their company is a source of loss to the Western Union of many thousands of dollars yearly, as it unquestionably is.'

"The assumption that the Gould cables are a drag upon the Western Union is based on figures officially given by the Direct Cable Company. For the half-year ending in July last, the Direct Company reported gross earnings of £36,106. Assuming that the business for the last six months of the year just ending will show its natural increase, as well as the increase due to the revival of business, their receipts may be put at £75,000 for the year, or $375,000. This will represent 16⅔ per cent. of the pool receipts, which is the Direct Company's share. The Western Union Company as the lessee of the Gould cables receives 22½ per cent. of the pool receipts, which, using the Direct Company's figures as a basis of calculation, would be £48,743, or $243,715 for the first six months of the year 1885, or £101,250 for the year, equivalent to $506,250. The operating expenses, aside from repairs to cables, for the Direct Company's one cable in the first six months of the year were £17,206, or $86,000, or should the same rate hold good for the year, $172,000. The working expenses of the two Gould cables, outside of the expense for repairs, and these have been very heavy during the year just closing, would be at a very low estimate $150,000, and will probably be much more.

"The situation occupied by the company to its guarantor is, then, just this: It brings to the Western Union a gross revenue during the year now closing of $506,250. The Western Union pays out as against this receipt the guaranteed dividend of $700,000 on the capital stock and $150,000 for operating expenses, in addition to an unknown sum for repairs to the cables. Both cables were broken last February. The attempt made to find them in the winter had to be abandoned, and another attempt was made in the summer with success, the cables being again in use in September. Both attempts were, of course, at great expense. This was made apparent by Dr. Green, President of the Western Union Company, who in his recent report advising the reduction of dividends said the necessity for such reduction was due to extraordinary expenses incurred for litigated taxes—which, so far as this State goes, don't appear to have been paid yet—and for repairs to cables. As an offsett against this deficit the Western Union Company has, by its contract with the Cable Company, a uniform income of two cents a word for every word transmitted through it. Even this additional income is not sufficient to wipe out the deficit between the recipts and the regular charges—dividends and operating expenses—by many thousand dollars.

"With such a showing the American Telegraph and Cable Company shareholders are anything but satisfied. So far as can be ascertained there is no fund set aside as a renewal to be used in the construction of new cables when those now in use shall be worn out. Every other cable company has such a fund, based usually on the theory that the life of a cable will be but sixteen years. To the renewal fund there is yearly set aside, by some of

them, 6 per cent. on the actual cost of the cable. The Direct and Anglo-American have large renewal funds; the American none at all apparently. Naturally the stockholders of the latter company ask, 'What will become of us when our cables are worn out?' and 'What will become of us when the Western Union guarantee expires, if it lives and continues to pay us our dividends for fifty years?' A satisfactory answer has not yet been given. Active and formidable opposition in the cable business, and the constantly and rapidly decreasing earnings of the Western Union Company have put these stockholders on the anxious seat. This is especially the case since rival cables have been projected, and seem likely soon to be constructed.

"The only source of consolation which the stockholders find is the fact that their cables are comparatively new, and are known to be good ones, having been made by the Siemens Brothers, of London, who constructed the Direct, the French, and the Mackay-Bennett cable. They have met with no more accidents than have befallen other cables, and in case of breakages, which are repaired at any time within a year from the time of breakage, their lessees will receive their share of the pool receipts, in accordance with the provisions of the pool agreement."

Commenting editorially upon the subject, our contemporary remarked:—

"In connection with the recent action of the New York Stock Exchange in striking the American Cable Company's stock from its list the American journals are again discussing the evils of the stock-watering practices so popular with the cable companies. According to the *New York Times*, the 'pooling' system has its advantages as well as its disadvantages for honest stockholders, and one of them is that under it secretive directors are powerless to keep from the public the amount of a corporation's earnings, provided any other company in the pool publishes a statement of its own. From this it is easy to calculate to an approximate certainty the receipts of all the other members of the pool, so that stockholders cannot be kept in ignorance of the fact of their property, by reason of mismanagement or otherwise, is expending more than it is receiving. This calculation, applied to the American Cable Company, which has leased its wires to the Western Union on a 5 per cent. guarantee of its $14,000,000 of stock, shows that the Gould Cables are an expensive luxury for the telegraph company to hold as a plaything. During the year just ended the 5 per cent. dividends guaranteed by the Western Union Company, with the running expenses and cost of repairs, have not only eaten up all the receipts from the business of the cables, but from $200,000 to $300,000 besides, which represents an absolute loss to the telegraph company. It may pay the Western Union to maintain the American Cable Company at this exorbitant rate merely to frighten off other cable companies, but, says our contemporary, business men, who deal in tangible properties instead of watered stock, will not regard this as a judicious investment. It is possible that the figures arrived at by the New York Stock Exchange Committee, which showed the utter worthlessness intrinsically of the cable stock, may have been the real cause for dropping that stock from the Exchange list, an act for which 'technical errors of certification' was given as the reason. But the exposure of rottenness in anything controlled by Jay Gould can no longer be a matter of surprise to the initiated."

OVERHEAD WIRES AND THE RECENT STORM.

AT a meeting of the Board of Works for the Wandsworth District, last week (Mr. G. P. Meaden presiding), the Surveyor (Mr. Pilditch) reported that the storm of the morning had done considerable damage to the overhead wires in Battersea, that several of the posts on housetops had been broken down, and that in many cases the wires had been coiled round the lamp posts. The chairman (referring to the recent litigation of the Board with the Post Office on the subject) said this was just what the Postal authorities said would not happen. Mr. Morton suggested that the Board should communicate with the Home Secretary on the subject. Mr. Lidiard said there was no doubt serious damage had been done, and he thought the Board should obtain information from all parts of London. Mr. Wood moved that the Board should write to the various Local Authorities in the Metropolis in order to obtain the fullest information possible. Mr. Sidland seconded the motion. The surveyor stated that the broken wires were the new copper ones, which they had been assured would resist such influences, but they had been the first to go. The resolution to communicate with the various Vestries and District Boards was unanimously agreed to.

A fire broke out early on Wednesday morning, last week, on the premises of Messrs. Duffy and Son, saw mills proprietors, in Vauxhall. The heavy storm had disorganised the electric fire alarm, and the state of the roads prevented the rapid arrival of the engines, so that the fire had made great headway before attempts could be made to extinguish it.

A number of letters have appeared in the various daily papers upon the subject, for the most part dwelling upon the danger to life and limb caused by the overhead wires. Messrs. Beal, Son and Chartres, of Waterloo Place, give the following account in the *Times* of an experience of theirs:—

"We had so narrow an escape of our lives here yesterday that it is as well to record it as a protest against overhead wires. A large skylight covers one of our offices, and, owing to the breaking of the connections of one of the trunk wires, portions of the parapet of the adjoining house were hurled through the skylight, of a weight sufficient to have killed any one seated therein. No one for the istant was in the room, but the chairs in which they would have been seated bear evidence of the force at which the stone and brickwork descended. The company have acknowledged their liability, but the moral we venture to draw is 'No more overhead wires.'"

Mr. George Russell, replying to a previous letter, wrote, also in the *Times*:—"In Mr. Beachcroft's letter about overhead wires, he refers to the report presented by the Select Committee, of which I was chairman. Permit me to say a few words in self-defence. After a careful examination of exhaustive evidence, the Committee did not feel justified in recommending the total discontinuance of overhead wires. But, in the draft report which, as chairman, I proposed to the Committee, I urged the following precautions:—All overhead wires should be subject to proper supervision. Overhead cables should not be permitted. Where more than 10 wires are run along a line, the local authority should have power to compel them to be taken underground. The local authority should also have power to regulate the length of span, and other conditions necessary to secure the safety of the public. No power to pass and keep wires over private property without the consent of the owner or occupier should be given to any company or private person. All owners of land or occupiers of houses should have power, by notice to the local authority, to cause the removal of wires crossing their property and belonging to any company or private person. No company or private person should have power to make attachments to houses or buildings without the consent of the owner or occupier. By-laws for the regulation of all wires, as to substance, length of span, durability, &c., should be made for the whole of London by the Metropolitan Board of Works. Every wire should be registered with the local authority, and all ownerless wires be removed. The duty of inspecting wires and maintaining them in proper order should devolve on the owners, who will be responsible for the results of neglect. These precautions were rejected by the majority of the Committee, and a report was presented, inconsistent, in my judgment, with the public safety and the rights of private property."

Mr. J. F. B. Firth is determined to make the occasion serve his particular purpose, as may be gathered from the following letter, which, however, does not seem to make quite clear the point with which he desires to impress us; still, his letter is interesting, and we reproduce it. He says:—"The breaking of overhead wires in the recent snowstorm will not be without its advantage if it compels Parliament forthwith to legislate on the whole question of telephone and telegraph wires. A Select Committee of the House of Commons considered the question last session, and by a majority reported in favour of an extension of the powers of companies and of granting them authority to pass wires over private property and to attach them to private buildings without the consent of the owners. The minority of the committee were in favour of much more stringent regulations with respect to overhead wires. I venture to think that the recent breaking of wires in London has strongly emphasised the necessity of such restrictions as they recommended. In the *Times* of Friday you printed a letter from my old friend Mr. Beal detailing the effect of a falling wire, from which it appeared that the preservation of his life was only due to his temporary absence from his official chair. It would have been a Nemesis indeed if a man who has devoted an arduous life to the advocacy of the establishment of a competent local authority in London had borne witness by his death to the necessity of such an authority. The wire which fell was one of the heavy cables or trunk lines which cross the streets in all directions. These bundles of wires ought in all cases to be put under ground, and the minority of the committee were of the opinion that wherever more than 10 wires were run along a line they ought also to be taken underground. There is very little danger in a sound, properly attached, overhead wire of reasonable span, but provision ought to be made for its frequent inspection and for its renewal at stated periods. The Post Office, as a great public department, exercising its functions for the benefit of the whole community, has made provisions to this end, and may be relied upon to extend them by the light of recent experience. The need of legislation is greatest in the case of private wires. The great increase of breakages in the recent snow-storm over the storm which visited us five winters ago was due, not so much to a heavier fall of snow, as to the increased age of the wires; and unless we have effective legislation forthwith it is likely that a future storm of similar magnitude will produce far more disastrous results. The Post Office authorities know pretty well what is the length of the life of a wire. In the pure country air it will last nearly 30 years; but in air like that of Newcastle-on-Tyne, impregnated with sulphur and acid, it will not last three years. London air is better than the air of Newcastle, but there are many thousands of wires crossing our streets that are in a period of advanced decay. The danger from these wires increases year by year. The Post Office authorities, with increasing knowledge of the conditions and effect of our atmosphere and of the best wires to use, are increasingly careful in their system of inspection and renewal. But there is no control over the wires of private companies and persons. Worse than this, there are in London an enormous number of ownerless or derelict wires. They have been put up at some time for the purpose of communication, and when for any reason they are no longer required they have been left in order to save the trouble of removing

them. Anyone can satisfy himself of this if he will note the pillars carrying wires and which show sometimes as many as five or six coming to an abrupt termination. The right to erect wires at all ought to be the subject of properly-regulated control. At present it is the custom of both companies and individuals to stretch wires in any direction they please, over both private and public property. This is an undoubted infringement of the rights of private owners, but one of so small and peculiar a character that it is not often challenged, and indeed, as the wires are often erected at night they are not always noticed. While it may be admitted that the Post Office, acting under full public responsibility, should have power to pass and keep wires over private property without the consent of the owner or occupier, it is doubtful whether such power should be given to any private company or person. It is surely not too much to ask that every wire should be identified and registered with the local authority. There ought to be by-laws regulating the period of renewal, the length of span, and the substance of the wires, and no wire ought to be erected by an irresponsible person or company except with the consent of the owners of property and of the road authorities of the district through which it passes. Immediate legislation is necessary for London. The needful by-laws may be made by the Metropolitan Board of Works, and the needful registration and control placed in the hands of the London vestries. Every legislator walking down Pall Mall in a snowstorm incurs the risk of decapitation. Surely we need not wait for this catastrophe before removing the danger."

THE ELECTRIC TRAMCAR IN BERLIN.

WE are pleased to observe that the German newspapers, scientific and non-scientific, are unanimous in their praise with reference to the Reckenzaun car, which has now been some weeks before the Berlin public. Saturday last appears to have been a grand day. At the invitation of Herr. G. A. Plewe, gentlemen interested in tramway matters came from all parts; there were directors and engineers from Stettin, Hamburg, Cologne, Vienna, Potsdam, Aix-la-Chapelle, Charlottenburg, Magdeburg, Dresden, Spandau, in addition to those of the Grosse Berliner Pferdebahn, present on Saturday morning and afternoon. It was, in fact, a kind of congress of specialists, who made it their business to watch the performance of the vehicle, which has caused quite a sensation for some time past; and the result is, according to reports from several leading papers, that the boards of directors of the Berlin tramways, the Stettin and the Potsdam Tramways, have resolved to equip a number of cars forthwith with the electric apparatus, whilst all expressed their approval of the system. The car in question has for several days been under the entire control of officers of the Grosse Berliner Pferdebahn, and Mr. Reckenzaun was but a spectator during these official tests; the ease with which uninitiated persons could regulate the speed, start, stop, and generally control the vehicle caused great admiration and surprise on all hands. It appears that Mr. Reckenzaun has on the Berlin car introduced some substantial improvements, which were not on the one exhibited in London last year. The most difficult routes of Berlin were chosen; the car was overloaded every time with at least six persons, sometimes ten, above the regulation number, but every demand that could be made by the critics was at all times satisfied.

The Grosse Berliner Gesellschaft is probably the largest of its kind in Europe; it owns 620 cars and 5,000 horses; it pays yearly increasing dividends which amount now to 10 per cent.; it is, therefore, all the more praiseworthy that innovations of a promising character are being supported by this company. When will sufficient enterprise be forthcoming in this country to go and do likewise? We have already given descriptions of the Reckenzaun car and enumerated its many advantages; we need not, therefore, reproduce the lengthy articles of our contemporaries, but we must join them in their praise and their warm congratulations on the success of the system.

The Electric Light in the Royal Navy.—The Admiralty have directed that the sister ships *Alacrity* and *Surprise* shall be fitted at once with electric search lights as well as internal electric lighting.

NOTES.

Temporary Electric Light Installation.—On the occasion of the exhibition of pictures of the Alpine Club at Willis's Rooms, three of the rooms, viz., the card room, about 24 × 24 feet; the new room, 24 × 33 feet; and the tea room, 24 × 42 feet, were lit up by forty 20 c.p. Woodhouse and Rawson incandescent lamps suspended from the ceiling; the lamps being silvered were specially suitable, reflecting the light on to the pictures. Messrs. Woodhouse and Rawson, who were the contractors, had not much time allowed them, as three-fourths of the lighting had to be arranged for and carried out on the opening day of the exhibition before 3 o'clock; the work, however, was done as if for a permanent installation, and in accordance with the rules of the Phœnix Fire Insurance Office.

Electric Lighting in Hull.—Some time ago the Hull Corporation granted £10,000 to its Lighting Committee for the purpose of experiments in electric lighting. A number of arc lamps have now been erected in the Victoria Hall, and it is anticipated that the arrangements for the lighting of the hall will be completed in time for the coming musical festival to be held therein.

Domestic Electric Lighting. — Mr. F. Bumsted, of Cannock Chase Foundry, gives us the following information respecting the electrical plant at his house. The installation has been in operation for a few weeks and it is entirely satisfactory. There are 30 E. P. S. Co.'s cells, charged by a "Phœnix" dynamo, driven at 750 revolutions per minute by a small "Chandler high-speed engine" and vertical boiler (steam pressure 40 lbs.), mounted on four wheels; this, however, is only a temporary motive power, as Mr. Bumsted is now putting down a "Davey" motor The E. P. S. cells serve 40 lamps.

The Thomson-Houston Electric Lighting System. The Thomson-Houston Electric Lighting Company has during the past year formed no less than 51 subsidiary companies in the States and elsewhere, and the number of lamps operated by these companies, with those added to other installations previously existing, reaches the respectable total of 6,900.

Electric Lighting at Hatfield House.—On the occasion of the county ball given by the Marchioness of Salisbury at Hatfield House on the 6th inst., the following arrangements were made for the lighting by electricity of the house and grounds. The principal rooms, galleries and grand staircase were illuminated by upwards of 900 Swan's 20 candle-power lamps; the principal power for these lamps being derived from two waterwheels on the river Lea, which is a mile and a quarter distant from the house. The machinery used for generating the current consisted of two Siemens alternating current machines, one 16-light "Brush," and one Siemens direct current machine, the latter being driven by a 16 H.P. gas engine. The terraces and approaches to the house were lighted by six Clark-Bowman arc lamps, the current for these being supplied by an H gramme machine driven by a traction engine near the house. The lighting was in every respect a thorough success and gave great satisfaction, there being not the slightest interruption to the working during a period of 16 hours. The whole installation was carried out by Mr. Shillito. It may be remembered by our readers that the Marquis of Salisbury has been a pioneer in the matter of electric lighting and the use of electricity, and that his lordship has utilised this agent in a variety of novel ways by the transmission of electrical power, such as for grinding corn at farms situated at some distance from the water-power, pumping water and driving the ventilating apparatus at the house, driving the lathes and saws in the workshops, pile driving, dredging and cutting weeds in the river, &c.

A Powerful Blaze.—A Chicago dispatch in the *New York Times*, dated December 31st, says :—"The highest and most powerful group of electric lights in the world is to-night blazing around the tower of the Board of Trade Building, at the foot of La Salle Street, a little over 300 feet above the ground. While the building was in process of construction the idea of crowning its highest point with a ring of lights was suggested by Elmer A. Sperry, a Cornell University man, 25 years old, who came here from Cortland, N. Y., three years ago and formed an electric light motor, and car brake company. Various circumstances prevented the execution of the scheme until the present time. Mr. Sperry's company put up the lights, the Board of Trade furnishes the power, and the other expenses are paid by subscriptions from owners of surrounding property, including the Federal Government and several railroad companies. There are 20 of the lights, and they are fastened to a ring of 4-inch gas pipe 29 feet in diameter. The ring hangs on steel wires three-quarters of an inch in diameter, running over sheaves placed at the extremities of four arms projecting from the tower near the top. By these ropes, which are attached to drums in the clock room, the lights are lowered, when necessary, to a balcony surrounding the tower at the dial, 68 feet below. The lights are of 2,000 candle-power each, and are connected with a 20 light dynamo of 29 ampères in the basement. The carbons will burn 15 hours if necessary. The lights are to burn every night in the year. To-night the glowing crown is visible from every part of the city and for miles away. It is reported that it can be seen at Michigan City, 60 miles distant across the lake. It is thought that the light can be seen from a point in the lake off Milwaukee. The railroad yards of the city are greatly benefited by the light."

The Electric Light on the Lyceum Stage.—A writer in a dramatic contemporary says :—"I am told that new wonders of electricity are to be introduced into the representation of 'Faust'. Sir F. Bolton is devising, or has devised, a scheme by which Mr. Irving can carry three different coloured lights in the inside of the peak of his cap. By means of these he can illumine his features as he chooses. The last few years have indeed seen remarkable changes in stage-lighting. Different coloured lime-lights thrown from the wings or other parts of the stage were accepted not long since as amazing inventions, though the flood or stream of rays which came from the machine crudely betrayed the origin ; but this will soon be obsolete. Another of the ingenious electrician's contrivances for Mr. Irving is to be a sword so charged that he can at will produce an electric light on the point. When Valentine has fallen, Mephistopheles will point to him contemptuously with this weapon, and the face of the dead man will be illuminated. I am afraid 'Spectator' will not approve, but I think the device will be extremely telling."

A further statement is that the moon in the Brocken scene is likewise to be charged, and will at a given time send out forked lightnings.

The Electric Lighting of Pianos.—Electric lighting by the application of storage batteries to pianos is now being developed. The case of the instrument conceals the materials for an illumination lasting over ten hours.

The Electric Light on Steamers.—The latest addition to the line of steamers owned by Messrs. Wilson, Sons and Co., the *Torpedo*, has been fitted with the electric light, by Mr. Thomas Muse, of Hull. A Paterson and Cooper's Phœnix dynamo supplies the current, and beside the usual incandescent lamps below, the installation includes side and masthead lights, which, under the new system, are said to be more satisfactory than formerly. This is the sixth of the Wilson line to be lighted by electricity, and as the others of the fleet lay up for repairs, they also will be lighted.

Electric Lighting at Hull.—Messrs. Barnett and Scott, jewellers, Whitefriargate, Hull, have had their premises lighted by electricity, and a number of representative men of the town were present, by invitation, to witness the inauguration. Electricity as a means of lighting the public streets of Hull was tried some time ago by the corporation, but after a time discontinued ; and it has also been used at dock, railway, and one or two large works in the town, but Messrs. Barnett and Scott have been foremost in its introduction to shop premises. A powerful gas engine has been placed in the back premises, and this is the motive power for supplying electricity throughout the establishment. After a test of the lighting had been made, the company present partook of refreshments, and the Mayor proposed the health of Messrs. Barnett and Scott, in responding to which Mr. Barnett said the burning of gas in their show premises and workshops had been found to be injurious to the health of their assistants and workpeople generally, and to have a damaging effect upon their goods ; this had led to their trial of the electric light, which did not give off heat and fumes, as gas did. The plant consists of a 6 H.P. Otto gas engine, which has been laid down by Messrs. Crossley Brothers, Limited, a Ferranti dynamo, and a Siemens exciter. The lamps are the Woodhouse and Rawson incandescent, of 20 candle-power each, and they are arranged suspended from chandeliers on either side of the extensive shop, six lamps forming a cluster. A sun-light of lamps is fixed in the centre of the ceiling, and eight lamps in each compartment of the window. The whole of the lamps in the shop give an illumination stated to be of 2,000 candle-power, producing a most brilliant effect. The offices and workshop will also be fitted with the same light. The installation has been carried out under the direction of Mr. Thomas Muse, electrician, of Hull.

Station Lighting at Glasgow.—The experimental lighting by electricity of the Central Station, Glasgow, has proved so successful that the system is about to receive important additions. Within a few days five or six lights will be added to the existing number. Of these one will be placed outside the covered way at the Gordon Street entrance, showing as far as Buchanan Street and Hope Street, another at the exit in the latter street, and a third will be erected on the parapet of the Argyll Street Bridge. The engines fitted up are powerful enough to supply electricity to the Bridge Street and Eglinton Street Stations.

The Electric Light in the Manchester Art Gallery.—Mr. Alderman Hopkinson, at the recent meeting of the Manchester City Council, in moving the adoption of the proceedings of the Art Gallery Committee, said the electric light had been an immense confort and advantage, although it was not altogether perfect yet.

Electric Lighting of the Wallasey Steamers.—At the last monthly meeting of the Wallasey Local Board, the minutes of the Ferry Committee included a resolution as to the placing of electric lights on the Wallasey steamers. When this improvement was effected, there was no doubt whatever that all persons residing in the parish would be highly pleased. It was said that the total expense would be £764. The oil lamps cost £17 15s. per annum ; the electric light would only cost £7 10s. The minutes were adopted.

Electric Head Lights.—The Chicago, St. Louis, and Pittsburg Railway Company (Panhandle) and the Cincinnati, Indianapolis, St. Louis, and Chicago Railway Company (Big Four), have taken the electric head lights off engines where they have been trying them for some months. The light has given satisfaction on all sides, with the exception that it is so bright and strong, that it makes the signal lamps rather dim. The drivers, however, would probably become used to them, and this would be no objection. The companies claim it would cost them about 400 dollars for each engine to fit them up for electric light, which is more than they can afford at present.

Station Lighting at Edinburgh.—About the time the electric light was tried in Princes Street, Edinburgh, some years ago, the North British Railway Company introduced it for the lighting of the Waverley Station. The Railway Company has found it to its advantage to continue it; and the improvement in the lighting of the station is said to be most marked. The directors have just completed an extension of the electric light to the refreshment and waiting rooms, the booking hall, &c., and to the entrances and platform of the Suburban Railway platform. The lights, which have been in use up to the present time, are on the arc system; while the extension which has just taken place is on the incandescent principle. About 135 such lamps have been fitted up, each combination being of 20 to 30 candle-power. The different departments are arranged in groups, so that one set may be lighted while the other is not. The new lights will be run with the present engine power. In that way the working expenses will practically represent only the cost of the additional coal required. Taking that with the interest on the price of the lamps, and the amount which will be written off for depreciation, the Railway Company estimate that the station will be lighted by the electric light at about half the expense of gas. Economy is certainly one of the objects kept in view, and another is the preservation of the appearance of such rooms as the refreshment rooms—an expensively painted ceiling in one of which has been greatly blackened by gas within four years. The work has been carried out by the Anglo-American Brush Electric Light Corporation, under the direction of Mr. Geipel, their superintendent, and Mr. Thomas Carswell of the North British Railway engineering department.

The Telephone in Austria.—According to a *Times* telegram, the use of the telephone is fast extending in Austria. Communication has just been established between the town of Gleichenberg, one of the principal industrial centres of Bohemia, and Gablonz, another manufacturing town 12 miles distant.

The Telephone at Cardiff.—The Western Counties and South Wales Telephone Company has just opened a telephone exchange at Cardiff. The rooms of the company occupy the whole of the top floor of the central block of the New Exchange Buildings in Mount Stuart Square. There are two services, the "commercial" and the "domestic." The former embraces day and night communication, exclusive of Sundays, and is connected with the postal telegraph office, by means of which subscribers may receive or forward their telegrams without extra charge by the company, and the free use of any call rooms which may be opened in the town. Connection will also be established with the central police station and fire office. It is also proposed to connect the service with the leading cab-stands. The cost of this service for any distance within one mile of either of the exchange centres is £14 if for one year, £13 per annum if for four years, and £12 if for seven years. The "domestic" service is open from 9 a.m. to 6 p.m. daily, Sundays excepted, the distance being limited to within one mile of either of the centres. This service—the cost for which is £12 for one year, £11 per annum for four years, and £10 for seven years—embraces communication during the before-mentioned hours, and the free use of any call rooms which may be opened in the town. Through communication between Cardiff and Newport is obtained by trunk lines provided by the company for those who are subscribers to their exchange in either or both towns at the rate of £6 per annum for a single connection.

The Telephone at Fire Stations.—At the last monthly meeting of the Burton Town Council it was suggested that the utility of the suburban fire stations should be increased by telephonic communication between them and the borough brigade stations. The suggestion was to be considered.

Invention of the Telephone.—Dr Lawson Tait, of Birmingham, has written the following letter to the *Scientific American* upon the subject of the invention of the telephone:—"I have read with much interest your articles on the invention of the telephone originally by Reis. I have also read the work of my friend, Prof. Silvanus Thompson, on this subject, and I have discussed the matter with him. I think I am in a position to supply a small link in the chain of evidence, which, though not important, may really prove to have a good deal, and certainly is not devoid, of interest. I was a student of medicine in the University of Edinburgh from 1860 to 1865, and being much interested in physical research, I was very frequently in the shop of Messrs. Kemp & Co., which used to stand near the entrance of the old Edinburgh Infirmary. Probably many of your readers have, like myself, visited that well-known establishment, and they will remember that it consisted really of two shops—one in which chemicals were sold, and the other, which had a separate entrance from the street, yet connected with the first by a door of communication, was occupied chiefly by physical apparatus, and was not common to the ordinary customers of the shop. Mr. Kemp died somewhere about the year 1861, and the business for some time, until, I think, about the middle of 1864, was managed by an extremely intelligent assistant named Mr. Shearer, of whom for many years I have entirely lost sight. Could Mr. Shearer be discovered, I fancy that he could give some extremely interesting information about the point which I am about to indicate. As near as I can identify the date, in December, 1862, a very simple looking instrument was shown to a number of his customers by Mr. Shearer. That instrument is depicted accurately on page 342 of your journal (Nov. 28th, 1885). It was connected in a circuit with a battery, and by means of wires to a transmitter of a rather different form from that which you figure on the same page, but precisely identical with one which is figured on page 97 of Professor Silvanus Thompson's work. Mr. Shearer had his apparatus in action, the transmitter being arranged in one shop, while the wires passed through to the receiver in the other. In common with many others of those who frequented the shop, I heard articulate words, which I could appreciate accurately, pass through this instrument from one shop to the other. At that time Mr. Alexander Melville Bell was a well-known teacher of elocution in Edinburgh, giving public readings, to which many of the young men of the town were strongly attracted. He was, indeed, a very well-known man in Edinburgh, and lived there with his family. When I met Mr. Graham Bell at Plymouth, in 1877, when he first exhibited his telephone, I immediately recognised him as the son of Mr. Melville Bell. I cannot say whether he was resident in Edinburgh at the time that Shearer exhibited Reis's telephone in Kemp's shop, but I think it is very likely he was, and I feel almost certain that I have seen Mr. Melville Bell as one of the frequenters of that shop. So that it seems to me that nothing is more likely than that it was through this chain that Reis's telephone was transferred to America, and there became developed. Mr. Melville Bell was then engaged in the contrivance of a universal alphabet, upon which he has published an extremely interesting book. Reis's telephone was greatly talked about in Edinburgh at the time of its exhibition by Shearer, and I think it is extremely likely that Mr. Melville Bell would go to the shop to see it, and he might have been accompanied by his son."

The Telephone at Prescot.—At the last monthly meeting of the Prescot Highway Board, the surveyor said he had had an application from the telephone company to erect several poles for the extension of the telephone wires for the use of the county constabulary, in Sandy Lane, south of the workhouse, Narrow Lane, and St. James's Road. He did not think there could be any objection. The board decided to leave the matter in his hands.

The Bell Telephone Case.—The *Scientific American* of January 2nd contains the following :—"Associated Press reports state that the Interior Department has decided to recommend that the Attorney-General authorise suit to be brought in the name of the United States to test the validity of Bell's original patent. Although the full text of the decision will not appear for some days, it is said that it will set forth, among other things, that 'the specification of Bell's patent contains nothing about the capability of Bell's instrument to transmit articulate speech, but only claims for it the power to transmit "vocal sounds;" that an instrument may transmit "vocal sounds" without being a speaking telephone; and that, in point of fact, Bell did not invent a speaking telephone until after the issue of his patent, as appears from the record.' For these reasons, it will be urged, the validity of the Bell patent is fairly questionable."

The Drawbaugh Telephone Case.—According to the New York *Electrical Review* of January 2nd, the Drawbaugh telephone syndicate held a meeting in Boston on the previous Friday, and considered a communication from Senator Edmunds, recommending an appeal from the decision of Judge Wallace. It was voted to make the appeal prior to January 1st, and the expectation is that the Attorney-General will see that the case is placed upon the calendar so as to insure a hearing this winter.

The Telegraph in Canada.—It is stated in Canada that before many months have passed an independent system of electric telegraph will be opened by the Canadian Pacific Railway Company. As a commencement the company is already erecting between Montreal and Winnipeg wires of exceptionally large capacity, and when completed these two cities will be in as close and quick communication as are Toronto and Montreal. The facilities of communication, too, between Montreal and Ottawa, already large, are in process of being more than doubled.

Postal Telegraph Festivities at Plymouth.—On Thursday, last week, the annual dinner of the clerks employed at the Plymouth Postal and Telegraph Offices took place at the Farley Hotel, under the presidency of Mr. J. N. Foot. The toasts included, "The Postmaster-General" and "The Telegraph Staff." During the evening Mr. Charles Collings was presented with a microscope in recognition of his services for 10 years as hon. secretary of the Postal and Telegraph Service Benevolent Society.

An Important Appointment.—The New York *Electrical Review*, of December 26th, contains the following announcement :—"The many friends of Sr. Saturnino Islas, of the City of Mexico, will be gratified to learn of his appointment as Director General of all the Government telegraph and telephone lines in the Republic of Mexico. Sr. Islas is eminently fitted for the high position thus conferred, having had many years' experience as superintendent of telegraph for the Mexican railroad, and has ever been prominently identified with the telephone and electric light in our sister Republic. The Mexican press speaks in the very highest terms of his work of reform already inaugurated, and we predict a bright future for him. He is possessed of great executive ability, and his integrity is known to be irreproachable." Sr. Islas should make an efficient Director-General, having been trained in the telegraph department of the English Railway Company, whose lines connect Vera Cruz and the City of Mexico, and of which he became telegraph seperintendent. He was an officer in the Mexican army during the French invasion, and distinguished himself.

Large Telegraph Contract.—A Wolverhampton firm, Bayliss, Jones and Bayliss, has obtained an order of the value of £50,000 for the supply of wire and fittings to the Indian Telegraph Company.

Telegraphic Communication in Bulgaria.—In virtue of an arrangement between the authorities at Philippopolis and Adrianople, railway and telegraphic communication with Eastern Roumelia, which has been suspended since the outbreak of the revolution, will be re-opened in a few days.

Telegraph Poles in Dangerous Positions.—The Chairman of the Prescot Highway Board at a recent meeting drew attention to a pole erected opposite the almshouses in Warrington Road, and which, he said, was very objectionable. The Surveyor said the pole in question was a telegraph pole, and had been erected by the postal telegraph officials. He had several times ordered poles to be put further back, and he had given instructions that no more were to be put down without his consent. He had written on the subject. Mr. Leatherbarrow asked if they had any power over the poles. Could the Government place them where they liked? The Clerk: No; they must have our consent. Mr. Leatherbarrow said a man recently walked against the pole, and he had to be carried home insensible. The pole had been painted white, but it could not be seen on dark nights, as there were no lamps about. It was resolved that notice be given to the Postmaster-General that unless the pole be removed within fourteen days the board would remove it and charge him with the cost.

Telegraph Poles at Oxford.—At the last monthly meeting of the Oxford Local Board, the recommendation of the General Purposes Committee, that application be made to the Postmaster-General asking him to remove the nine telegraph poles north of St. Margaret's Road, and to substitute underground wires, was adopted.

Telegraph Revenue.—The receipts upon the telegraph revenue from April 1st, 1885, to January 9th, 1886, amounted to £1,345,000, against £1,355,000 received from April 1st, 1884, to January 10th, 1885.

Electrically Protecting the Dead.—Electricity has been invoked to secure the tomb of the dead millionaire, Vanderbilt. The niche in the vault in which the coffin is placed is connected with an electrical alarm, and even if a tunnel could be driven to the tomb, any attempt to remove the body, or any tampering with the wires of the alarm, would be made known immediately at the head-quarters of the detectives. A registering alarm clock has been placed near the gate of the vault, and at short intervals the guard is required to register his presence at the tomb.

Mysterious Death.—Mr. Langham, the Coroner for West Middlesex, last week opened an inquiry respecting the death of a young Dutchman, John de Wilde, aged about 25, a telegraph instrument maker, whose body was found in the River Thames below London Bridge, embedded in the mud, and whose forehead bore evidence of foul play. The deceased was last seen with another foreigner, named Degenkolb, who attended the inquest, but whose evidence was refused, as he was an atheist and declined to take the customary oath. The inquiry was adjourned.

More Anglo-American Cables.—It is reported in Glasgow that the Anglo-American Telegraph Company is contemplating the laying of two new cable wires to America "to meet the large and increasing business." But we do not quite think Glasgow is the best place to go to for the purpose of learning the intentions of the directors of the Anglo-American Company.

Corrections.—We stated in error last week that the paper on the dynamo, by Mr. W. M. Mordey, which we published, appeared in "the Journal of the Physical Society," instead of "in the *Philosophical Magazine*."

In the letter of Mr. Aug. J. Littleton, on page 44, last week, it is stated that the dynamo gives *above* eight available E.H.P.; this should have been *about* eight.

Science in Japan.—The Minister of Education at Tokio, Japan, has obtained leave to have translated into Japanese Prof. Guthrie's syllabus of instruction in elementary practical physics, as pursued at the Physical Laboratory of the Normal School of Science and Royal School of Mines, South Kensington. The Japanese Government proposes to introduce this system of practical instruction into the elementary schools as well as into the normal schools of Japan. Prof. Guthrie has promised to write a preface to the translation.

A Novel Desk.—Mr. F. J. Davis, of Plymouth, and Mr. E. H. Middleton, of Devonport, have jointly invented what may be described as a portable illuminated desk, which promises, if its merits can be proved, to be of great utility on all occasions when the light of nature is not available. The desk is in shape not unlike an ordinary street lamp, with the exception that wood takes the place of glass. By the pressing of a spring at the lower part of the front the desk opens and affords every facility for writing. It is stated that the light for this desk can be supplied with equal facility by means of electricity, gas, oil, or candle. It is suitable for a sick room, the bridge of a steamer, mines, or open air meetings, and one has already been fitted on board the bridge of the P. and O. steamship *Bengal*. It may be added that the desk is both water-tight and air-tight, and has the additional merit of being ornamental as well as useful.

Electric Railroads in Boston.—A project is on foot to build and operate elevated railroads in Boston on which trains are to be run by electricity. No particular system is yet mentioned.

The Gaulard and Gibbs System.—The National Company for the Distribution of Electricity by Secondary Generators has issued a pamphlet explanatory and descriptive of the system of distributing electrical energy invented by Messrs. Gaulard and Gibbs. It commences with a chapter on "The Advantages of Electric Lighting," and, throughout, is written in an interesting manner.

Electrical Subjects in American Newspapers.—Our leading journals would do wisely to follow the example of those of America, which invariably pay great attention to electrical subjects, and give no small amount of space to them. In illustration of this we may cite the case of the *New York Times*, which on January 1st contained between eight and nine columns dealing entirely with such subjects as the telephone, electrotyping, electric lighting, primary batteries, India rubber, &c. We can scarcely expect emulation of this record, but we should like to see the daily papers treat the electrical industry as "a real live thing."

The Franklin Institute Incandescent Tests.—Reverting to the matter of Messrs. Woodhouse & Rawson's lamps and the tests at the Franklin Institute, the *Mechanical World* replies to our concluding query upon this subject a fortnight ago, that it "would not matter a bit" to the Franklin Institute what names certain lamps bore if they were properly entered for the tests, "but that was just the point at issue." Then our contemporary says :—"What Messrs. Woodhouse & Rawson complain of is that the lamps were entered without their knowledge, that they had no means of watching the tests or of protesting against them before they were complete." What we have to say is that if Messrs. Woodhouse & Rawson had read the technical journals of this country or of America, they could not have overlooked the paragraphs periodically given, calling attention to the progress of the tests. The circumstances attending the tests on these particular lamps are unfortunate, but we repeat that the Franklin Institute is exonerated from all blame in the matter; and to those who doubt this assertion, we say, Read the report.

Obituary.—In Mr. George Richardson, the Receiver and Accountant-General of the Post Office, who died on the 6th instant, the country has lost a public servant of great experience and capacity. He entered the Post Office in 1845, and was at first employed in the Money Order Department, which he left in 1861, in order to take an active part in the organisation of the Post Office Savings Bank. He subsequently performed much arduous and responsible work, notably in connection with the transfer of the Telegraphs to the State and the establishment of the Postal Order system. He was appointed Assistant Receiver and Accountant-General in 1877, and succeeded the late Mr. George Chetwynd, C.B., as Receiver and Accountant-General in 1882.

J. D. F. Andrews and Co.—We have received from the Woodside Electric Works, Glasgow, a copy of the electric light catalogue issued by this firm, in which is given descriptions, illustrations, and prices of the Woodside dynamos, Andrews's patent arc lamps, accumulators, incandescent lamps, fittings of various kinds for house and ship lighting, switches, measuring instruments, tools, electric light leads, belting, and other accessories. The list is in a handy form, and is well printed.

Electric Lighting Contracts.—A friend asks us if we can inform him how decisions are arrived at as to which firm, tendering for contracts, shall carry out the work. As an instance of what he considers somewhat enigmatical, he tells us that the contract for an electric lighting installation, which shall be nameless, was placed in the hands of a firm whose tender was £500 higher than that of another competitor, the total contract being less than £2,000. *Quien Sabe.*

Induction.—We are indebted to Mr. David Brooks for advanced proofs of the New York *Electrician*, in which his article on "Some Considerations Regarding Induction" first appeared.

Electrical Formulæ.—The letter which we publish on this subject from Mr. Moon is very lengthy, and we would draw the attention of our correspondents to the desirability of observing brevity in their communications, more especially when the interest in the controversy appears to be centred in the disputants only. We had thought that a more general interest would have been manifested in Mr. Andersen's papers, for his formulæ agree, we believe, with the practical results obtained by machines constructed in accordance therewith. Should Mr. Andersen deem an answer to Mr. Moon to be necessary, we will insert it, but it will then be desirable that this matter should be allowed to rest.

Overhead Wires in the States.—At Harrisburg, U.S., some of the city officials and the newspapers have recently been attacking the aerial lines, claiming that the wires must go underground. The City Council in December discussed an "ordinance" ordering all wires to be placed underground, but indefinitely postponed its decision. The superintendent of the telephone company, and a representative of the electric light company, ably addressed the council, pointing out the difficulties in the way of carrying out the proposition. The former read extracts from the report of the Brooklyn Commission, which stated that, after examining six hundred methods, the commission was of opinion that no permanent underground system had yet been discovered.

Anglo-American Telegraph Company.—Mr. S. Jackson, who spoke at the meeting of the Shareholders' Association in connection with the Anglo-American Telegraph Company reported in our last issue, asks us to correct the statement attributed to him that the original promoters of the cable received "£1,200,000 for £100,000 in twelve months." The latter figures should have been £600,000.

Telephony in the North.—We are informed that the New Year opens with every sign of increased activity as far as the Northern District Telephone Company is concerned, and from all appearances 1886 will be a very busy time in the district, despite the depression in all branches of trade; for, after the first shock of the annual subscription is got over and the cost is reckoned up, it is generally found that the telephone, instead of proving an extra expense, becomes a source of economy. The line between Wingate Colliery and Hartlepool, a distance of about 12 miles, was opened in time for Christmas greetings and good wishes to be exchanged through it, and it is a very important piece of work, constituting as it does the first part of the trunk line between Hartlepool and Sunderland. When so much is being written and argued with regard to overhead wires and the recent snowstorms, it is satisfactory to report that in this district there has been a complete immunity from the troubles and dangers which have been so plentiful in London and other districts, and there has not been a single case reported of wires being broken by the snow or the gales in Sunderland. To anyone who knows the character of the storms experienced lately in that place, this fact speaks volumes for the excellence of the work. At the annual *soiree* of the Literary and Philosophical Society at Newcastle, the installation of telephones lent by the company proved the centre of attraction, and much surprise was caused amongst the guests at the ease with which they could listen to the concerts that were going on in various remote parts of the building; much credit is due to Mr. Dalzell, the company's inspector at Newcastle, for the success of the experiment. Owing to the increase in the number of subscribers, and the want felt for improved appliances, the company has just ordered a new multiple switch board for Sunderland, which will undoubtedly prove a great boon. The trunk line between Newcastle and Sunderland is also being strengthened with additional wires. At the annual meeting of the company in December, Mr. C. B. Clay, who, for some years past, has been well known in connection with the United Telephone Company in London, was formally appointed manager of the Northern District Telephone Company, a position he has practically held for the past six months, and the appointment of one so well known in the telephone world will undoubtedly prove a great cause for congratulation to the directors and employés of the company.

Overhead Wires and the Storm.—The District Manager at Nottingham of the National Telephone Company informs us that during the late snow storms, although the company has different kinds of wire, such as iron, copper and bronze, on the same poles, there was not a single breakdown recorded. One of the junction poles, 105 feet high, carries 190 wires, consisting of No. 17 copper, No. 71 covered iron and 18 G bronze. The trunk lines to Loughborough, Long Eaton and Ilkeston, and the three suburban junction lines also escaped interruption. The first named trunk loop exceeds 40 miles in length, being connected on the metallic system and passing through a well-wooded district. Thus it may be gathered that it is not impossible to construct ærial lines which shall resist any ordinary pressure of snow. This record of unbroken wires and that sent us by the Northern District Telephone Company, is exceedingly satisfactory in the face of much that is being said and written just now.

The Telephone at Nottingham.—The National Telephone Company has been gradually extending its area of operations in the Nottingham district, having recently established connection with Long Eaton, Basford, and Loughborough, and to this list Ilkeston has just been added. Placed in such a busy locality the Nottingham exchange should prove highly successful; but a query which suggests itself to us after perusal of a statement in a local paper, is, *Why* is it impossible for the National Company to accept messages from "other than its regular patrons and subscribers?" Why may not call offices be opened in Nottingham as well as elsewhere.

Aurora Borealis.—On Saturday night an unusually brilliant display of the aurora borealis was witnessed in Scotland. Immediately previous to the auroral display, the longer telegraph lines were slightly interrupted by earth currents, which reached their maximum at 6.50 p.m. At that time, from observations taken at Aberdeen, there was a south to north earth current of 28·83 milliampères, and the currents continued with varying force till 7.15 p.m.

At East Linton the first appearance was at 8 p.m. It began in the zenith, extending in beautiful coruscations from south-east to north-west, afterwards in several lovely circles in the north, lighting up the sky as at sunrise.

At Stonehaven, about 8 p.m., the aurora was very bright, shooting from the northern horizon to the zenith, whence, after describing a circle, it spread all over the heavens, and afterwards disappeared. For about an hour the telegraph wires were affected by the storm, and the electric bells at the railway signal cabins were rendered quite useless. Similar reports come from the west of Scotland.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES

Brighton Electric Light Company, Limited.—An agreement dated 5th inst., and filed on the 6th inst., between this Company and Frank Welden Bentley, of 4, Sydney Street, South Kensington, provides for the adoption and confirmation by the company of the agreement dated 1st ult., for the purchase of the goodwill of the business of Mr. Robert Hammond, at Brighton, and Mr. Bentley is indemnified from all liability in acting as trustee for the company, in connection with the said agreement.

Consolidated Electric Company, Limited.—The annual return of this company made up to the 12th June, 1884, was filed on the 11th inst. The nominal capital is £100,000 in £1 shares, the whole of which are taken up and are fully paid.

Gülcher Electric Light and Power Company, Limited.—The registered office of this company is now situate at the Battersea Foundry, Wellington Road, Battersea.

CITY NOTES, REPORTS, MEETINGS, &c.

The Western and Brazilian Telegraph Company, Limited.

THE report of the directors for the year ended 30th September, 1885, states that the total earnings amount to £127,396 9s. 5d., an increase of £21,222 1s. 1d. compared with last year.

The working expenses for the year, exclusive of renewals of cable, amount to £60,155 19s. 4d. as against £61,871 5s. 2d., a decrease of £1,715 5s. 10d.

The company has had to replace by sheathed cable during the year 156 miles of the old unsuitable type of cable; the amount thus expended, £15,175 10s. 6d., has been charged to the renewal fund.

Including the amount brought forward from 1884, the balance to the credit of the revenue account is £42,296 17s. 9d., of which £10,000 has been placed to the renewal fund, leaving £32,296 17s. 9d., from which the directors recommend the payment of a dividend of 2¾ per cent. free of income tax, leaving £3,459 0s. 3d. to be carried forward. This will give to the preferred ordinary shares 5 per cent. for the year and one-half per cent. on account of the year ending 30th September, 1884.

The directors would have been enabled to recommend the payment of a larger dividend to the shareholders, but for the loss on exchange which has continued to increase, and amounted during the year to £10,648 6s. 3d.

In order to place the system between Pernambuco and Rio de Janeiro in perfect order, by the immediate removal of the remaining old strand type, which had become faulty, the directors invited tenders for the manufacture of 200 miles of sheathed cable. The company's ss. *Norseman* was ordered home to carry this cable to Brazil, and has now arrived out on the coast. During her absence the duty was provided for by placing the *Viking* in the centre of the system to be ready for any emergency.

The directors again draw attention to the extensive renewal of the old strand type of cable during the year; the steps now taken will complete the removal of this faulty type from the main revenue earning sections of the company.

Owing to pressing competition efficient and speedy repairs have been absolutely necessary in order to keep the traffic over the company's line. The remaining mileage of the strand type will now be reduced to 226 miles between Ceara and Pernambuco, and there is therefore a near prospect of reducing the heavy expenses caused by the maintenance of repairing ships, by re-arrangements rendered practicable owing to the permanent improvement effected in the company's system.

It may be as well to remind the shareholders that under many difficulties, no less than about 2,300 miles of solid sheathed cable have been substituted for the old unsuitable strand type.

The Direct United States Cable Company, Limited.

THE report of the directors for the six months ended 31st December, 1885, contains the usual statements of account for the half-year, which shows that the revenue, after deducting outpayments, amounted to £38,115 3s. 5d. against £68,824 5s. 2d. (after similar deductions) for the corresponding half-year of 1884: being a difference of £30,709 1s. 9d. against the half-year under review, owing to the operation of reduced tariff and competition.

The working and other expenses for the same period, including income tax, &c., but exclusive of cost of repairs of cables, amounted to £16,631 13s. 0d, leaving a balance of £21,483 10s. 5d. as the net profit of the half-year, making, with £10,733 14s. 7d. brought forward from the previous half-year, a total balance of £32,217 5s. 0d. For the corresponding half-year of 1884 the working expenses and other payments, exclusive of debenture interest, amounted to £16,857 15s. 0d.

Interim dividends of ¾ per cent. each, for the quarter ending 30th September, 1885, paid 24th October, 1885, and for the quarter ending 31st December, 1885, payable 23rd January, 1886, together amounting to £18,213, have been declared.

The sum of £8,037 3s. 9d. has been set aside to the reserve fund, thereby increasing that fund to £320,000, leaving a balance on the revenue account of £5,967 1s. 3d., which has been carried forward.

The interruption in the short section of cable, mentioned in the last report, was repaired on the 27th August.

A break occurred in the main section on 4th September last, and was promptly repaired on the 7th of the same month. The cost of the above repairs, £3,362 12s., has been charged against the reserve fund.

With a view of affording additional facilities to the public joint offices have been established by the associated companies at Glasgow, Bristol, and Havre.

Eastern Telegraph Company, Limited.

THE revenue of the company for the half year ended September 30th was £331,420, the available balance being £194,107. Interest on debentures and debenture stocks absorbed £27,260, the interest on the preference shares took £20,297, and the two interim dividends of 1¼ per cent. each, with a bonus of 1s. per share, or ½ per cent. on the ordinary shares, took £114,000, a balance of £32,549 being carried forward. In August last an International Telegraph Conference was held in Berlin, to which the English companies were invited to send representatives. Important questions were discussed affecting the interests of the companies, and a proposal urged by the Indian Government to reduce the rate between England and India was agreed to. Important reductions in the European tariffs were also voted by the conference. It is estimated that these alterations will affect the company's revenue to the extent of £40,000 a year, but the directors trust that with the growth of traffic resulting from reduced rates the loss will be gradually diminished. Her Majesty's Government having invited tenders for establishing submarine telegraphic communication between St. Vincent (Cape de Verd) and the British possessions on the West Coast of Africa, this company and the Brazilian Submarine Telegraph Company joined in sending proposals which have been accepted, under which a subsidy of £19,000 a year for 20 years is granted by the Government in respect of a cable from St. Vincent to Bathurst, Sierra Leone, and other British possessions southward to the mouth of the Niger. A separate company called the African Direct Telegraph Company has been formed to carry out this project, and the directors, with a view to the additional traffic which will be brought over to this company's lines, and the strengthening of its interests in Africa, have agreed, subject to the approval of the shareholders, to provide one-third of the capital required. As the larger part of such capital will be raised by debentures of the African Direct Company, it is estimated that this company's proportion of the balance to be issued in shares will not exceed £75,000, which the directors propose should be subscribed and paid for by the issue of a sufficient amount of this company's 4 per cent. debenture stock, which is now at or above par. The arrangements with the Governments concerned are not yet completed, but further explanations on the subject will be given at the meeting.

Hammond Electric Light and Power Supply Company, Limited.—Mr. William Theobald, F.C.A., liquidator of this company, has given notice that he is prepared to pay the debenture-holders upon application at the offices of Theobald Brothers and Miall, 23, St. Swithin's Lane, E.C.

The Direct United States Cable Company, Limited.—The Board has resolved upon the payment of an interim dividend of 3s. per share, being at the rate of 3 per cent. per annum for the quarter ending 31st December, 1885; such dividend to be payable on and after the 23rd inst.

International Electric Company, Limited.—At a general meeting of this company, held on Wednesday, resolutions for the voluntary winding up of the company were confirmed, and Mr. Ernest Cooper, of the firm of Cooper Brothers & Co., of George Street, Mansion House, was appointed liquidator.

The West Coast of America Telegraph Company, Limited.—The directors of this company have declared a dividend for the past half year of 3s. per share.

TRAFFIC RECEIPTS.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 31st December are £2,017, as compared with £2,339 in the corresponding period of 1884. The September receipts, estimated at £3,876, realised £3,913.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending January 8th were £2,336, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited

The West Coast of America Telegraph Company, Limited. The gross earnings for the month ending December 31st were £3,825.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ended January 8th were £3,091.

NEW PATENTS—1886.

251. "Method of generating electricity." S. VYLE. Dated January 6.

281. "Galvanic batteries, &c." J. HOSKING. Dated January 7.

283. "Electro-mechanical governor." O. E. WOODHOUSE, F. L. RAWSON. Dated January 7.

290. "Elements of primary batteries." H. WOODWARD. Dated January 7.

299. "Electric indicators for house bells." J. C. REVILL. Dated January 8.

311. "Telephones." R. H. RIDOUT. Dated January 8.

321. "Electric battery." G. J. ATKINS. Dated January 8.

335. "Voltaic batteries." D. G. FITZ-GERALD. Dated January 8.

337. "Electrical transmission of sound." W. R. LAKE. (Communicated by J. W. Bonta.) Dated January 8. (*Complete.*)

355. "Electric measuring instruments." S. EVERSHEAD. Dated January 9.

398. "Method of supplying liquids and mixtures to electrical batteries." J. T. ARMSTRONG. Dated January 9.

409. "Street curb for receiving electric wires." W. REDDALL. Dated January 9.

450. "Electric lamps." B. J. B. MILLS. (Communicated by A. Million.) Dated January 11.

469. "Electric lights and apparatus for illuminating by electricity." A. C. FERGUSON. Dated January 12.

483. "Elements for primary batteries." H. WOODWARD, E. M. GREGORY. Dated January 12.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

2117. "Improvements in electric telephony." J. G. LORRAIN. Dated February 16. 6d. The inventor employs an apparatus consisting of or comprising in its simplest form a disc, plate, or other shaped mass of conducting material capable of movement as a whole, or of movement, bending or vibration in part—like a diaphragm, for example. From the centre, or any convenient part of the said disc, plate, or other shaped mass, hereinafter called the plate, a point, also of conducting material, projects. Opposite this point, and in close proximity thereto, is placed a

suitable conductor, of any desired shape, which is hereinafter called the knob. Either the plate or the knob may be in electrical connection with the line or with earth. This apparatus may act both as transmitter and as receiver.

2162. "An electric light switch." A. P. LUNDBERG. Dated February 17. 8d. Relates to an improved switch of the description already described in the REVIEW.

2165. "Certain improvements in the construction of electrical batteries." J. T. ARMSTRONG. Dated February 17. 8d. The outer part of the battery (that is the part now understood as the box or chamber part) is made in sections with flanges and then the said sections are joined together with screws and nuts, or in any other suitable manner; these sections have flanges made of ebonite, earthenware, glass, insulated wood, or other suitable material. The joints are made tight with asbestos, putty, rubber, or other substance that may be found to answer the purpose of making a tight and lasting joint.

2287. "Improved electrical accumulators or storage cells." T. S. SARNEY and A. S. HAMAND. Dated February 19. 6d. In carrying the invention into effect the plates are formed with a thick rib of the metal of which they are composed, situated horizontally across their surfaces and by preference about the centre. To the ends of these ribs are attached stout strips of metal leading through the electrolyte to the connections with the main conductors of the accumulator. The plate in this shape is now completely surrounded with the porous mixture, the whole mass slightly pressed into a uniform shape in a mould, the plate and its porous covering being then bound round with suitable material and finally being covered with stout unglazed paper, placed in a proper oven to evaporate all moisture.

2395. "Improvements in resistance boxes and similar apparatus for use with incandescent electric lamps and for other purposes." G. A. NUSSBAUM. Dated February 21. 8d. The inventor employs a substance having a composition corresponding more or less with that of the black lead ordinarily used in black lead pencils, and consisting mainly of a mixture of plumbago or graphite and clay. These materials are prepared, mixed, and moulded into rods, pencils, blocks or other desired form for use as resistances, in a similar manner to that adopted for the manufacture of black lead.

2747. "The construction of storage or secondary batteries or electric accumulators." W. SYMONS. Dated March 2. 4d. The batteries are made chiefly or entirely of carbon in plates, rods, or cylinders, in which cavities or spaces are made for containing oxide of lead or other suitable material.

2795. "Improvements in secondary batteries." H. J. ALLISON. (Communicated from abroad by P. Benjamin, of America.) Dated March 3. 6d. The liquid employed is prepared by adding to a zinc sulphate solution magnesium oxide in such quantity as will be sufficient to neutralise the sulphuric acid set free when the zinc sulphate solution is decomposed on the charging of the cell. The anode of the cell is preferably made in the following manner. The material of which it is to be composed, such, for example, as lead or an alloy of lead with a non-oxidisable metal such as antimony or bismuth, is melted and then cooled until it becomes plastic. While thus plastic it is stirred until it assumes a finely-divided condition and shows a tendency to solidify. The mass is finally allowed to cool in a mould when the small particles of which it is composed cohere at their points of contact, thus rendering the electrode very porous, causing it to expose a large active surface, and thus greatly saving time in the formation of the plate.

3353. "Improvements in apparatus for opening electric circuits to prevent damage, applicable especially to the derived circuits in which incandescent lamps are placed." T. NORDENFELT. (Communicated from abroad by O. F. Jönsson, of Stockholm.) Dated February 10. 8d. To open a derived circuit in which are incandescent lamps; in order to protect this circuit from destruction in the event of short circuiting, an apparatus is employed consisting of attachments, each having a clamping screw and each being fixed to an insulating board; they receive the wires of the main circuit. The current passes from one attachment to a spring and on the end of the spring is a hook which engages with another similar hook on another spring. Through this spring the current passes to an electro-magnet from which a circuit wire is led to one or more incandescent lamps, whence it passes to, and is connected with an attachment clip on the main lead. On one of the springs an iron piece is attached serving as an armature to the electro-magnet, but it is kept remote therefrom by the elasticity of the spring. The electro-magnet is adjustable and may be moved nearer to or farther from its armature to regulate the safety apparatus and set it to be operated by a larger or smaller current as may be required, due consideration being had to the maximum current which the derived circuit can pass without danger to the circuit or the lamps. If this maximum is exceeded, owing to short circuiting or other cause, the electro-magnet by its attraction moves its armature, whereby the springs become detached from one another, an interruption thus occurs and destruction is obviated.

3358. "Improvements in and relating to electro-dynamic motors and dynamo-electric generators." T. J. HANDFORD. (Communicated from abroad by F. J. Sprague, of New York.) Dated March 14. 1s. 1d. The main feature of the invention is the use of a continuous field circuit wound sectionally in layers, the coils of each section of a series being wound upon the whole length of the core or of that portion of the core which is enclosed by the series, and the sections are connected together so as to form a continuous and unbroken series of coils. Connections from the bights of these coils are brought to suitable contact blocks on which travel arms which form the inlet and exit terminals of the supplying circuit. Means are provided for changing the connection of the terminals of the supplying circuit from one part of such field circuit to another, whereby the effective magnetic moment of such field coils is varied in any desired progression and direction.

3798. "Improvements in electric batteries." W. R. LAKE. (Communicated from abroad by H. L. Brevoort and I. L. Roberts, of America.) Dated March 24. 8d. Consists in a battery carbon and a reservoir or liquid holder arranged at the upper portion of said carbon, and communicating with the pores or interstices of the carbon, so that liquid will be supplied from it to the carbon and will percolate thence towards liquid in the cell of the battery.

5758. "Improvements in casing for carrying under foot telegraph, telephone, and other wires, pipes, or tubes." H. O. ADAMS. Dated May 11. 8d. Consists in constructing the curbs of street and other pavements or paths of a hollow section or sections so as to contain and carry therein wires, tubes, or pipes used for telegraph, telephone, or other purposes.

6878. "Improvements in the construction and arrangement of electrical batteries, and in devices or contrivances to allow of the emptying or withdrawal from, and the re-charging of, such batteries with the exciting fluids." J. T. ARMSTRONG. Dated June 5. 8d. Consists in improvements on the invention described in Patent No. 2165, 1885.

9570. "Improvements in the apparatus used for generating currents of voltaic electricity, the improvements being applicable to electric table lamps and general domestic electric light and power." R. H. COURTENAY. Dated August 11. 11d. The inventor constructs the inner cells with substances of different degrees of porosity, one side being carbon, which becomes the substitute for the ordinary carbon plate, the other side being preferably unglazed earthenware, or other substances of a porous nature can be used.

12205. "Regulating apparatus for arc electric lamps." C. DORNFELD. Dated October 13. 6d. Relates to an improved construction of electric arc lamps, wherein the distance of the carbon points is regulated by means of mechanism consisting of a rack and pinions, an escapement wheel and its anchor, and an electro-magnet in a shunt circuit.

12851. "Improvements in conduits for electric wires and cables, and for other purposes." G. D. SUTTON. Dated October 27. 8d. Relates to conduits for electric wires and cables, and for other purposes; and it has for its object the furnishing of a practicable method of laying electric wires and cables beneath the surface of the ground, without materially interfering with the paving of the carriage ways or side walks of cities.

12932. "Improvements in electric gas lighting burners." A. J. BOULT. (Communicated from abroad by D. Rousseau, of America.) Dated October 27. 8d. This invention applies to that class of burners in which the movement of a lever pivoted on the burners operates the gas valve to turn on the gas, and simultaneously actuates the electrodes to produce the igniting spark. In most all burners of this type the valve is a rotary friction plug of the common form, and is revolved by a ratchet movement of the lever. In this present invention the burner is provided with a minute double seating poppet valve, which works without packing or friction in a direction across the gas passage of the burner, and the usual ratchet and cam wheel between the valve lever and the pawl lever or sparking lever is dispensed with entirely, and a direct engagement is formed between the valve lever and sparking lever, so that the forward movement of the lever opens the valve and produces the igniting spark, whereas the back movement of the lever positively closes the valve.

13109. "Improvements relating to arrangements or systems of underground electrical conductors, and to apparatus for use in connection therewith." W. R. LAKE. (Communicated from abroad by D. H. Dorsett, of Chicago.) Dated October 30. 8d. This invention is an improvement in systems of underground electrical conductors, the improvement being directed to facilitating the laying and distribution of the conductors throughout a city, or any part of the same; to the better insulation of said conductors, and the prevention of inductive or other injurious effects arising from the close proximity of circuits for different purposes, such as telegraphing or telephoning on the one hand, and electric lighting on the other.

13453. "Improvements in electric clocks." E. G. COLTON. (Communicated from abroad by F. Haenichen, O. Haenichen, and O. Sebass, all of New York.) Dated November 6. 8d. Relates to an improved electric clock which can be run for a considerable time without recharging the battery, and in which the contact points are exposed to little wear by oxidation, owing to the complete neutralisation of the residual magnetism in the cores of the actuating electro-magnet and the prevention of induced currents; and the invention consists of an electric clock, the pendulum of which receives impulses from a crutch oscillated by a lever attached to the armature of an electro-magnet. The lever actuates the hands of the clock by intermediate gearing. The residual

magnetism in the cores is neutralised by sending a current in reverse direction through the coils of the electro-magnets, which is accomplished by suitable circuit closing and reversing devices and a disconnector operated by the armature of the electro-magnet.

13668. "Improvements in telegraphic instruments." G. W. STEWART. Dated November 10. 8d. The invention consists in part of a telegraphic instrument or sounder comprising a pivoted bar connected to the armature of an electro-magnet or magnets, and carrying a pointed projection through which a message can be received by the sense of touch alone, the vibrations of the armature being communicated through the pivoted bar and its pointed projection to the finger of the operator.

CORRESPONDENCE.

Re Electrical Formulæ.

There are some people who, rather than admit that they are wrong, will revert to the most pitiful prevarication, and the final subterfuge of such people is, frequently, the use of a burlesque style of argument. I am sorry that Mr. Andersen has thought fit to adopt such a method of arguing.

This argument, first begun upon magneto machines, has been since led away from that subject and other matters introduced, until, in the last number, no mention whatever is made of the original subject; but Mr. Andersen has taken each of my last remarks seriatim, and has asked me to explain them at a length which is quite incompatible with the space of the ELECTRICAL REVIEW at my disposal. I will, however, humour him as far as the small importance of the subject will permit me.

Mr. Andersen says: "The formulæ in my (Mr. Andersen's) paper having been established by ordinary algebraical reasoning, I will now ask Mr. Moon to, in a similar way, prove that any one of them is wrong, or that something contrary is correct. For if formulæ IV., VI., and VIII., in my paper are correct, then it is a physical impossibility that a case such as the one Mr. Moon alludes to can exist." But it is impossible to establish by algebraical reasoning the correctness of the connection between a formula and its physical attributes. When mathematics are used in physical research an equational expression is assumed to represent the relation between each of the factors of a problem, then by equational transpositions, the relation between one, or several, of the factors and the remainder is determined. But although such algebraical manipulations may have been performed without mistakes (as Mr. Andersen has seemingly done) the resultant formula would, of course, be inexpressive and useless if the fundamental assumptions did not clearly express the problem; consequently it is absurd for Mr. Andersen to say his formulæ have been established by ordinary algebraical reasoning. Moreover, it is impossible, in any algebraical formula, to express the whole of the relations of the factors of a physical phenomena, some we are not cognisant of, others must perforce be left to be assumed; we can only hope to express in the formula as much as is relevant to the argument, leaving out that which will be tacitly assumed. My objections to Mr. Andersen's formulæ are that they do not express the whole of the facts necessary to the argument; that they are not arranged to show clearly the relation of the factors; and that they are not even accompanied by an intelligibly worded explanation of the restricted circumstances under which they must be taken to apply. He has not, moreover, rightly interpreted the meaning of his own formulæ, and by giving formulæ for general use which are really applicable only to particular cases, he has robbed them of the little merit which was inherent in them.

I have nowhere suggested that Mr. Andersen had made mistakes in his algebraical manipulation, consequently his invitation to me to prove such errors, or as he puts it, "to shake an $\frac{a}{b} = c$," is out of place.

On pages 466 and 507 I have fully explained my objections to Mr. Andersen's formulæ, and have endeavoured to show him that when he treats of the *power and efficiency* of a dynamo, he can most clearly treat of the properties of each while the other is constant. But Mr. Andersen has slurred over, or wholly ignored these objections, and, for the sake of disputation, has entered at length upon merely incidental matter, and now it pleases him to allege that I have made loose assertions unaccompanied by facts or proofs. This is not true, since all my assertions have been accompanied by illustrative remarks which were quite adequate to the argument. It is evident that in Mr. Andersen I have to deal with one of those who, having advanced erroneous rules, refuse to see the arguments by which they are refuted.

Here is an instance of Mr. Andersen's inconsistency. He objects to my saying, "It is useless for Mr. Andersen to plead that his formulæ are for use *only* in the construction of dynamos," and then immediately afterwards says the statement, "From the preceding it is obvious that Mr. Andersen then proposed to use this particular quality of dynamos as a general criterion by which the values, *in regard to electro-magnet construction*, of machines of different types might be determined" is fairly correct. But judging by Mr. Andersen's succeeding remark, it would appear that even he is awaking to the fact that his term, "figure of merit," cannot be pandemic in its applications.

Referring, now, to Mr. Andersen's formula on page 431. Taking

$$\text{activity, } W = E\,C = F\,V\,L\,s\,a \qquad \text{IV.}$$

and

$$\text{electrical efficiency} = 1 - \frac{w\,a}{W} \qquad \text{V.}$$

by the usual substitutions he obtains

$$\text{electrical efficiency} = 1 - \frac{a\,\kappa}{F\,V} \qquad \text{VI.}$$

and then he says of IV. and VI., "so the percentage of internal waste is inversely proportional to F, while the activity is directly proportional to F." Whence Mr. Andersen concludes that F is a true expression for the merit of the machine. But why F more than V, which is similarly situated in Mr. Andersen's formula? Because (says Mr. Andersen) the velocity may be eliminated as a mere mechanical condition. But when we consider that the linear velocity of some machines is as much as three or four times that of others, it becomes evident that there are some electricians who do not agree with Mr. Andersen, that "the velocity is a mere mechanical condition." However, I hesitate to advance this as an argument, lest Mr. Andersen should avail himself of it as a bypath by which he may diverge from the main arguments.

I will now proceed to answer, in a convenient order, the questions Mr. Andersen has put to me. Referring again to the formula

$$1 - \frac{a\,\kappa}{F\,V} \qquad \text{VI.}$$

since

$$a \propto \frac{C\,L}{\text{size of field}}$$

therefore VI. may be expressed as

$$1 - \frac{\kappa_1\,C\,L}{F\,(\text{size of field})\,V}$$

Here "F" and "(size of field)" are similarly situated and, consequently, are of equal importance. To make an efficient machine we must not confine ourselves to making either "F" or "(the size of field)" a maximum, but *we must adjust the effective strength of the field to its size so as to make their product a maximum.*

This product, I opine, is the "figure of merit" which Mr. Andersen has been seeking, but which he has failed to discover. That he does not understand clearly the relation between "F" and the "(size of the field)"

is proved, I think, by his formula $\frac{a\,\kappa}{p\,\mathrm{F}\,\mathrm{V}}$ on page 447.

In this example Mr. Andersen proposes to increase the volume of the armature in the reciprocal proportion to the strength of the field. But this is not possible, since below the maximum value of the product

(size of field) × (strength of field),

the size of the field would of course decrease more rapidly than its strength would increase.

The importance of the other factors of the efficiency of the dynamo would not justify us in using either the size, or the strength of the field, or their product, as the only criterion of the value of the machine. For referring to the last formula more correctly expressed we have

$$\text{elec. efficiency} = 1 - \frac{\kappa_1\,\mathrm{C}}{\mathrm{F}\ (\text{size of field})} \frac{\mathrm{L}}{\text{function of V}}$$

Whence it will be seen that to make the machine most efficient it is now necessary to keep $\frac{\kappa_1\,\mathrm{C}}{\mathrm{F}\ (\text{size of field})}$ constant, while V and L are so adjusted as to make the quotient of $\frac{\mathrm{L}}{\text{function V}}$ a minimum.

In my last communication I said that Mr. Andersen's expression $\mathrm{F}\,\frac{w\,a}{w\,a + w\,m}$ would be a maximum with a small armature moving in a strong magnetic-field and performing little or no external work. This I thought evident enough without any further example or explanation; since the nearer the pole pieces are brought together the stronger the magnetic-field, *i.e.* "F," becomes; also since the size of the field becomes smaller $w\,a$ becomes greater, until at last $\mathrm{F}\,\frac{w\,a}{w\,a + w\,m}$ becomes a maximum when the size of the field is such that the armature is just large enough to keep the field-magnet excited, without performing any external work. Hence in this case the "figure of merit" is increased by making the machine less efficient and less economical.

I might also remark of this formula $\mathrm{F}\,\frac{w\,a}{w\,a + w\,m}$ that, on page 447 after Mr. Andersen had shown that in a particular case and under restricted circumstances a dynamo had an internal waste of $\frac{w\,a + w\,m}{w\,a}$ that of a magnetic machine, he thence concluded that the coefficient $\frac{w\,a}{w\,a + w\,m}$ could be applied to all cases without being qualified by any limitating data; consequently he has introduced the absurdity that I have previously explained.

Mr. Andersen says: "that the hope for efficiency of those recent machines which rely upon a weaker field and a comparatively large armature, is built upon sand." Mr. Andersen's opinion, possibly, may interest the designers of those machines more than myself. I need only here remind Mr. Andersen that they were designed by men of repute.

In my last communication I pointed out that machines must perform work all the same while their comparative values are being determined. Obviously, if we wish to compare the values of machines of different types we can most fairly do so by comparing machines of each type of equal power. But since it is frequently not possible to do this, the more general methods are to compare their values when the machines perform work at a rate proportional to their whole mass, or to the mass of their armature, or to their cost. Mr. Andersen prefers comparing the machines when they perform work at a standard maximum safe temperature; but this temperature would differ in different machines and would be difficult to determine; it would not, moreover, be always the most economical rate at which to work the machines.

Since Mr. Andersen calls upon me to explain so simple a thing as the difference between the sensibility and efficiency of telegraph instruments, I will define them as follows:—

The sensibility is proportional to the reciprocal of the current required; the efficiency and economic value are functions of the rate at which work is expended in the coils.

From his last remark it would appear that Mr. Andersen has yet to learn that matter and force are of equal importance in the economy of nature.

In conclusion, I can only express my regret of the manner in which Mr. Andersen has treated my friendly and just criticism, and hope that in continuing the discussion he will exhibit a better spirit.

W. Moon.

Galvanic Batteries.

Permit me to point out that it is inaccurate to say that my bichromate battery resembles that of Fuller except in employing more sulphuric acid, as stated in a note in your last issue.

Fuller's patent mercury bichromate battery has the zinc rod completely immersed in mercury which fills the porous pot.

A bichromate battery, similar to that now called Fuller's, was submitted to Mr. R. S. Culley, late Engineer to the Postal Telegraphs, by Mr. Lumsden and myself in the year 1869.

F. Higgins.

January 7th, 1886.

[Our correspondent is mistaken with reference to the Fuller battery. A small quantity of mercury (2 oz.) only is placed in the porous pot, this amount covers the lower part of the zinc rod to the height of about $\frac{1}{16}$th of an inch only, and the mercury amalgamates the rest of the zinc by creeping up it.—EDS. ELEC. REV.]

The Brake H.P. of Gas Engines.

As you have expressed a desire that I should furnish you with particulars of how I tested the brake H.P. of my ½ H.P. Otto engine, as the result appeared unprecedented, I have pleasure in giving you the particulars. The flywheel is 3 feet 6 inches diameter, consequently 10·9956 feet in circumference, say 11 feet. The speed I run the engine at is 196 revolutions per minute, hence the feet velocity of the periphery of the flywheel per minute is 2,156. At this speed a total weight of 18½ lbs. attached to a belt, the latter being thrown over the flywheel, is kept suspended, equal to 39,886 foot pounds, which represents a little over 1·2 H.P., being the power I stated in my former letter. I tested the engine again on Saturday night, after it had been running for six hours, with the foregoing result. I do not think this is unusual with the ½ H.P. engines made by Messrs. Crossley during the last two years, as I understand the cylinder is of wider bore than formerly.

J. H. Greenhill.

Belfast, *January 11th*, 1886.

Correction.

Kindly allow me space in the next edition of your valued REVIEW for pointing out that the following sentence in my paper, "The application of springs to polarised telegraph instruments," page 31, 11th line from top (the REVIEW of 8th January):—

"In the former instance (Siemens's relay), and in the latter, &c.," of course, is incorrect.

The sentence should read thus:—

"In the former instance (Siemens's relay), *but not* in the latter, &c."

K. Gulstad.

Copenhagen, *January 11th*, 1886.